POWER PLANT ENGINEERING

GENERATION - TRANSMISSION - DISTRIBUTION - UTILIZATION

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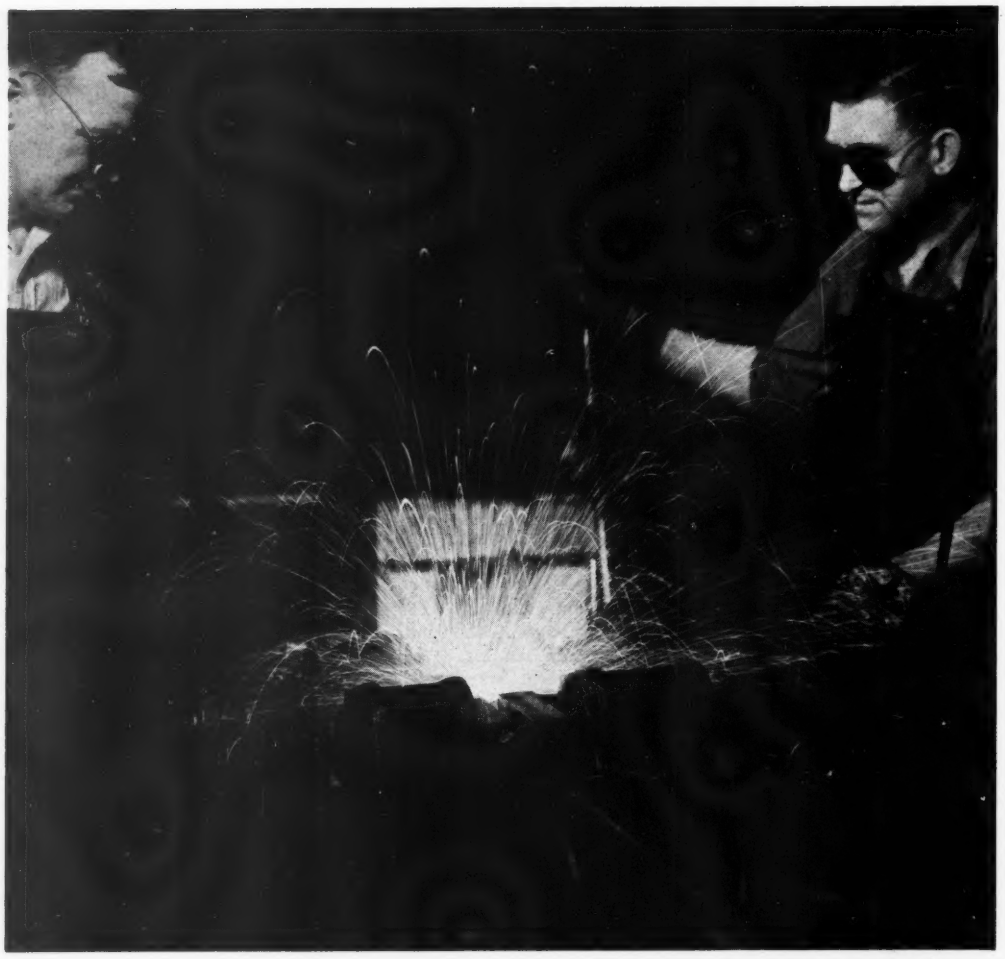

Photo, Courtesy A. M. Byers Co.

"The Smith, A Mighty Man is He"

THE "SMITH" of Longfellow's day was literally a mighty man—a man of brawn and stamina who fittingly symbolized the "muscular" civilization of his time. He was an admirable character well worthy of the Poet's eulogy, for his moral as well as his physical virtues. The picture Longfellow has given us of him will live forever in our hearts and serve to remind us of a simpler and, perhaps, a more satisfying age.

The village blacksmith is no more, the spreading chestnut tree has long since withered and died as have the children who looked in at the forge and caught "the burning sparks that fly like chaff from a threshing-floor." The modern blacksmith is a different type of individual. His brawn has given way to knowledge of strange new forces and their control. By the merest touch of a lever or switch he calls into play forces ten thousand times greater than those known to the village blacksmith. And the sparks of the modern smithy are of a kind and quality that startle and fascinate both children and grown-ups alike. Study the myriad flaming parabolas in the photograph above and see if you cannot read in their very trajectories the scientific nature of the processes which give rise to their being. In the resistance welding process, electricity does in an instant that which the village blacksmith could not have accomplished in hours.

WITH THE EDITORS

It's Just Too Bad

WHAT HAS become of that old time fulfilled promise—prompt delivery? Of recent months on every hand the complaint is all too frequent that purchasers of all kinds of power equipment cannot get deliveries on time or even within reasonable time after the date of promise. Inquiry as to why shipment has not been made often results in a detailed, usually highly technical explanation, which is only a camouflage for the real reason that the factory is over worked, either short of workmen or without sufficient equipment in working condition to live up to the promises made by the salesmen. The management then apparently puts it up to a bright telephone girl or a clerk, without much authority, to invent excuses and try to keep customers from cancelling orders, which usually ends up with the sympathetic but meaningless phrase "It's just too bad but we are doing absolutely the best we can."

Such a condition is strictly an indictment against management and cannot but have an undesirable effect upon the reputation of the concern that makes promises which cannot be fulfilled and depended upon to the letter. Before placing another order, the disappointed customer will naturally investigate all available competing companies' products and business methods and may even go so far as to select a product of inferior quality in order to be certain that promises will be fulfilled.

To workmen of the country, the overworked factories hold out encouragement that the millions now reported to be unemployed will find work at pay commensurate with their abilities. This again is a problem of management. It involves building up an efficient organization with sufficient skill to put out a high class product in schedule time. It requires providing and maintaining adequate machinery and equipment to keep this force of men continuously occupied. Financing the company's activities is usually the most difficult of all managerial problems. All departments must be coördinated.

Experience in fighting a depression has developed a technique in management which has little hope of being successful in an expanding market. Carrying on with obsolete equipment, making repairs on running machinery by taking parts from similar idle units, laying off skilled and experienced workmen because they are the highest priced, refusing to put new capital into a business that is sound but temporarily in difficulty, are practices that have grown up during the past strenuous years but they have left defects in many organizations working in and associated with the power plant field.

Power plants in the industrial field generally have been allowed to run down and, at this period of business pickup, the management finds itself with inadequate power equipment. It turns naturally to the public utilities for additional power, only to find, in some cases, that the utility is in about the same predicament and straining every effort to add new equipment to supply an increasing load. Failing to get complete satisfaction here, hurried plans are made for additional power equipment and orders placed with manufacturers, still further overloading these factories and delaying deliveries already on order.

Such confusion can only be straightened out when somewhat of a balance between supply and demand is reached in the orderly development of power generating plants, but judiciously made and religiously kept promises will do much to help in making possible some kind of orderly planning. To the engineer charged with the responsibility of designing power plants and selecting equipment, a note of warning should be sounded that too hasty planning is liable to result in the installation of equipment that will not meet the needs of the plant for a period of time commensurate with the initial investment and such temporary expedients are only the seed for troubles that will develop later on. It will then be the engineer's turn to say—it's just too bad.

Saint or Sinner?

SMOKE is the bane of our industrial civilization. As the major premise of the nationwide smoke abatement campaigns waged of recent years, the point is not debatable. Smoke means waste. It is evidence of poor design, a sign of squandered national resources, an indication of slovenly and careless operation, an evil Genii that casts a murky screen that cuts off the life giving rays of the sun and blights our otherwise fair and verdant land.

Yet during the depression years hundreds of smokeless chimneys presented a dismal sight. They might be seen in any industrial center yet because of the concentration and unobstructed view up the valley from Pittsburgh was particularly depressing. Industry has its faults yet no one who is mechanically minded and has played a part in this development can suppress a pang of pain at the sight of all this equipment standing idle, like ungainly giants at the bier of their master. Smoke stacks are markers on the industrial path our nation chose to tread and serve a useful purpose only when in active service.

With a stomach shrunk by several years of depression diet and our sense of the aesthetic starved, we must admit that the present view up the valley at Pittsburgh with dozens of smoking stacks is, in the language of Chic Sale, "mighty, mighty perty." A diet of smoke will soon nourish our national aesthetic sense, but it is doubtful if it can wipe out these first delicious mouthfuls of smoke rolling out of these chimneys which blaze the way to industrial recovery.

As originally built in 1921 with cribbing still in place. The new water softener is installed outside in the jog between the boiler room on the right and turbine room on the left

YOUNGEST of our major industries and rebounding from the depression with all the vigor of youth, the automobile industry is leading the race for national recovery and looks forward to 1937 as a banner year destined to break all records. Naturally, this activity is reflected in power plant building and practically all automobile plants have under way, or contemplate, extensive power plant programs.

Of these companies, the activities of the Buick Motor Co. at Flint, Mich., are particularly interesting, not because it is said to be the largest plant of its kind in the world, but because of the many factors involved, the engineering foresight and the fact that the modernization work is being carried on in the face of a production schedule which already taxes the capacity of the old equipment.

With the exception of tires, body and starting gear, the company, a unit of General Motors Corp., makes and assembles at this plant the Buick car and in addition supplies castings and parts for several other units of the General Motors organization. The plant extends 8825 ft. along the Pere Marquette Railroad as shown by Fig. 1, covers an area of 206 a. and employs about 12,000. With 1937 advertised as Another Buick Year, they expect to turn out some 250,000 cars.

Power Generation

As a general rule, that is insofar as it can be considered as a unit, the automobile industry does not tend toward the isolated power plant with complete power generation but rather toward a boiler plant either with no power generation or with but sufficient power generation to balance the need for low pressure steam. This is the result both of business policy and the peculiar needs of the industry. The high pressure top plant offers increasing possibilities as far as by-product power is concerned and will undoubtedly be widely adapted in the future. Without radical manufacturing changes, however, it is likely that power generation will continue of importance primarily as a heat balance medium. Territories in which these plants are located are well supplied with utility power at low rates, loads are heavy approximating the output of a small central station and the condensing water problem would be no small matter.

Furthermore, automobile plants are large users of compressed air and have heavy high and low pressure steam demands. High pressure steam at from 125 to 175 lb. pressure is used primarily for drop hammers which exhaust at or near atmospheric pressure to the low pressure mains for use in heating and process work, such as drying ovens, pickling and metal treating. To supplement the hammer exhaust, it is common practice to use steam driven compressors. This is a logical development because the compressors themselves are limited as to size and come within the range where the steam engine is highly efficient.

By using both motor driven and steam driven compressors, some degree of control may be exercised over the low pressure steam so as to avoid resorting to reducing valves or wasting steam to the atmosphere. It is obvious, however, that a combination extraction-mixed pressure condensing turbine is the ideal method of controlling the low pressure steam supply, especially so, with loads of the magnitude involved in automobile plants and where it is necessary to consider not only the variations in seasonal load due to space heating but momentary fluctuations due to differences in operation of various departments.

As one of the oldest companies, Buick's experience is second to none in the field. In 1921 the company built a new power plant which at that time was said to be "without doubt one of the finest and best equipped industrial power plants of its kind in the country." For a decade and a half this power plant served well but the increasing load, age of the boilers and need for improved heat balance facilities made it advisable to rebuild the boiler room and make changes in the generating equipment. These changes, begun in

Buick Steps Out

Four new 150,000 lb. per hr. high pressure pulverized fuel fired boilers and a new 3000 kw. combination bleeder-mixed pressure turbine modernizes Buick Motor Co. power plant to give high efficiency and better heat balance and concentrate boiler capacity in one building

June of this year and still under way, will double the steaming capacity of the replaced boilers, make provision for further capacity increase, make possible the retirement of an auxiliary boiler plant to consolidate all steam generation in a single plant, provide for a balance between low and high pressure steam and leave the way clear for additional by-product power by raising the boiler pressure. Although the new boilers will be operated at 175 lb. pressure, they are designed for 450 lb. w.s.p. Inasmuch as the steam load now ranges around 500,000 lb. per hr., a top turbine operating between 450 and 175 lb. could be expected to carry around 8000 kw., an appreciable percentage of the 22,000 kw. purchased power load.

Original Plant.

The plant, as originally built, was described in detail on page 835 of the September 1, 1921, issue of Power Plant Engineering. Briefly, it consisted of a boiler room, 140 ft. long, 88 ft. wide and 68 ft. from ground to ceiling, with nine 823 hp. and two 329 hp. bent tube boilers operating at 175 lb. pressure. The boilers, fired by underfeed stokers, are set high so that the ash hoppers dump direct to hopper bottom railroad cars. The two small boilers were originally set in a battery and provided with Dutch ovens for burning shavings and wood waste. Following the adoption of Fisher Bodies, the body plant was abandoned and with it disappeared the need for the wood burning furnaces. They were soon converted to coal firing using underfeed stokers.

In the engine room, 178 ft. long by 53 ft. wide and 44 ft. from basement to roof, were installed six 3000 c.f.m. 95 lb. two-stage steam driven air compressors exhausting to the low pressure steam system. Two turbo-generator units were provided, one a 3000 kw. mixed pressure condensing and the other a 5000 kw. straight condensing turbine, both set over jet condensers. Power is generated and purchased at 4600 v., 3 ph., 60 cycle with a 115 v. lighting bus and a 440 v. auxiliary power bus supplied through transformers. Excitation of both machines is from a common bus system supplied from two 75 kw. exciter sets, one steam and the other motor driven. All high tension busses and circuit breakers are located in a switch room in the basement and remote controlled from the main switchboard on the main floor. The high tension purchased power and generator busses are sectional-

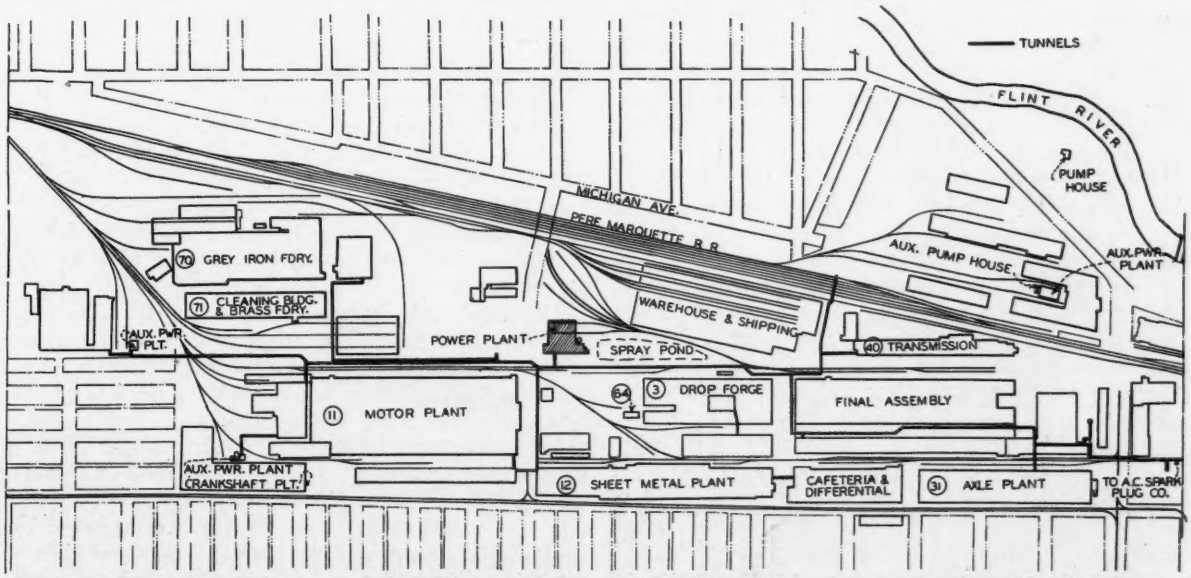

Fig. 1. An elaborate tunnel system connects the buildings spread along the railroad for a distance of over a mile. The total length of the property from north to south is 8825 ft., the length of the tunnels 2.25 mi., steam mains 23.8 mi. and distribution steam pipes 470 mi.

ized and tied together with 3000 amp. disconnect switches. The plant generators are normally operated in parallel with the utility system. Power is distributed throughout the works at 4600 v. with transformer banks located adjacent to the load. In 1931 a fifteen foot extension was added to the engine room and three synchronous converters with a combined capacity of 20,000 reactive kv-a. installed. As a consequence the power factor is high, and averaged 97.8 during 1935.

Auxiliaries

Plant auxiliaries, feedwater heaters, water treater, filters, feed pumps, service water pumps and forced draft fans are located in an auxiliary bay between the boiler and engine rooms. These auxiliaries are in general turbine driven. Three 100,000 c.f.m. fans, one motor, one turbine and one dual drive, supplied forced draft air through a sheet metal duct 3 ft. 6 in. by 4 ft. This duct, under the firing floor, is visible in Fig. 2. The boilers were arranged in two rows, each group connected to a 225 ft. radial brick chimney by a tapered breeching.

Condenser water is cooled in a large irregular shaped spray pond south of the plant. It measures roughly 445 by 90 ft., has 440 spray nozzles with an estimated capacity of 16,800 g.p.m. over a cooling range of 16 deg. F. River water, from a pumping station on the banks of the Flint River, is used in the fire lines and emergency supply tanks. City water is used for all other purposes including boiler feed makeup.

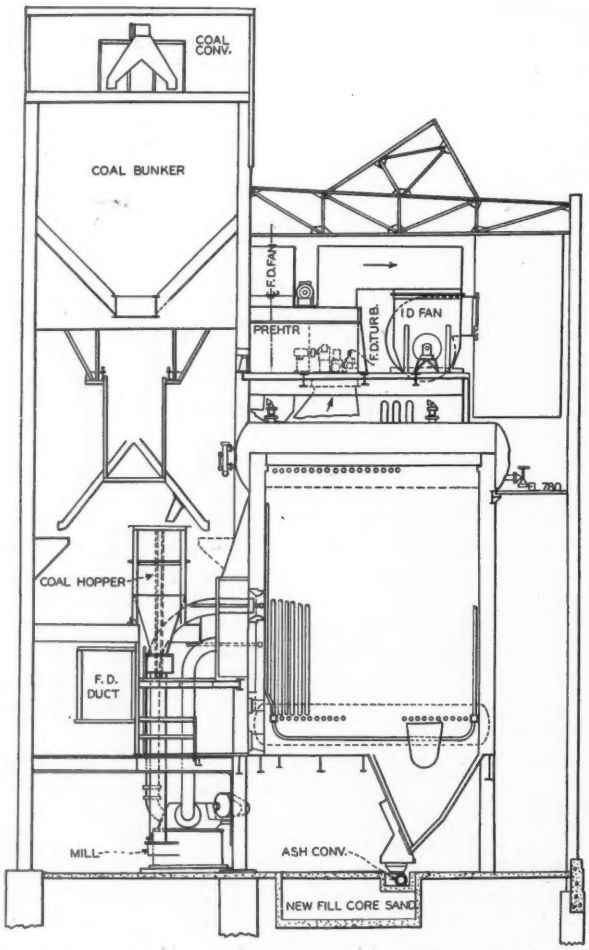

Fig. 2. Cross section of the boiler room. Four new boilers will replace five older units

The steam load is divided into the high and low pressure systems. The first consists of the turbo generators, the steam hammers and steam driven compressors which take steam at 175 lb. (boiler pressure). The latter two exhaust to the low pressure or exhaust steam system. This low pressure steam is used for building heating in the winter, for hot water heating, for the drying ovens, pickling tanks feedwater treating and other process work. The bulk of the heating is direct radiation on a vacuum system. There is, however, a considerable number of unit heaters in the newer shops and a large hot water system north of the power plant. All high pressure and low pressure steam lines, air lines, hot water and return lines are carried in the tunnel system shown by Fig. 1.

In addition to the six 3000 c.f.m. steam driven compressors in the power house, there are seven motor driven compressors of approximately the same size scattered throughout the works and pumping into the same 95 lb. air system. Steam exhausted from the hammers in the forge shop depends upon the production schedule and is not subject to control. By judicious juggling of the steam and motor driven compressors some degree of low pressure steam system control is possible. As the plant was originally laid out, steam in excess of low pressure requirements might be absorbed in the mixed pressure turbine or vented to atmosphere while any deficiency could be supplied from the high pressure system through reducing valves.

New Turbine

An excess of low pressure steam was presupposed and provided for by the mixed pressure turbine. Of recent years, however, the use of low pressure steam has been increasing faster than the high pressure steam load due primarily to the use of more drying ovens and such process requirements as Bonderite, a metal treatment used to prevent the spread of corrosion or rust through scratches in the enamel.

Provision for automatically taking care of this unbalance between the low and high pressure systems has been provided in the new plant by removing the 5000 kw. straight condensing turbine and installing a new 3000 kw. General Electric turbine designed for either extraction or mixed pressure operation. This unit is set over the same jet condenser used by the old turbine.

Although this change was extremely important from the heat balance standpoint, the major portion of the rebuilding program centered in the boiler room. There the five 823 hp. boilers on the east side of the firing aisle are being removed and replaced by four 150,000 lb. per hr., 450 lb. B. & W. integral furnace boilers fired by pulverized coal. This change will more than double the steaming capacity in the same space and the station capacity can be further increased by replacing the remaining 6 boilers on the other side of the firing aisle.

These changes can all be made without changing

the coal handling equipment, without major changes in the building and without building extensions, although space is available for such extensions if necessary. Inasmuch as the boiler room capacity can be increased to approximately 1,000,000 lb. per hr., practically double the present load, without such extensions, it is not likely they will ever be necessary.

Coal facilities consist of a storage yard served by a locomotive crane, a 36 in. double roll crusher at the track hopper, a reciprocating feeder and 18 in. belt conveyor feeding a bucket elevator. This elevator in turn discharges to an 18 in. distributing conveyor belt running the length of the boiler room over the 12 t. coal bunkers. The coal handling capacity is 75 t. per hr. A traveling weigh larry distributes the coal to the stoker hoppers of the old boilers and to four auxiliary hoppers on the new pulverizers as shown by Fig. 2.

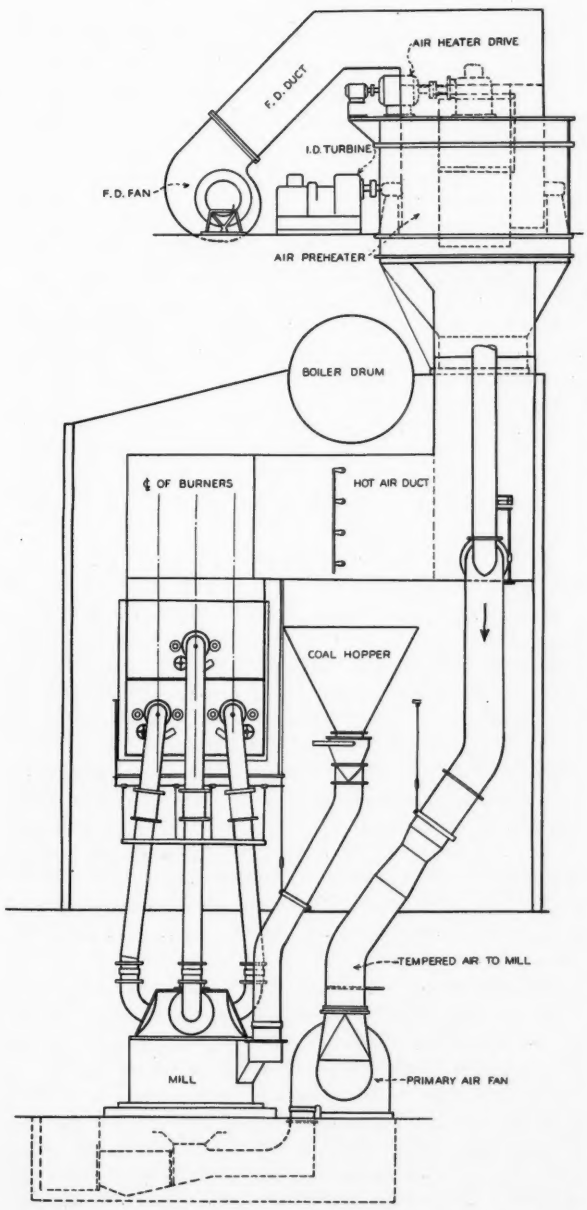

Fig. 3. Each new boiler is fired by one mill. Forced and induced draft fans and air heaters are on the top level. Boilers 1 and 2 are left hand as shown while boilers 3 and 4 will be right hand, this making the layout symmetrical about a centerline between boilers 2 and 3

The work was started in June of this year when two of the old boilers were removed to make room for the first new unit. When this boiler was put in service Sept. 8 another old boiler was removed and the second new unit erected. This was put into service the latter part of November and work on the remaining two is under way. The new turbine will be in service by the first of the year. These new units, although designed for 450 lb. pressure will, for the time being at least, be operated at 175 lb. Should changing conditions later warrant the installation of a top turbine, the pressure can be raised without any change further than replacing valves in the steam lines and installing additional superheater elements.

Each of the new boiler units has a steaming capacity ranging from 125,000 to 150,000 lb. per hr., depending upon the coal used, limiting factor being slagging in the furnace. As shown by Fig. 2, the ash track originally used has been filled in and a steam jet vacuum system installed. Boilers have four ash hoppers, one for the furnace and one for each of the three passes in the boiler section. These discharge, through hand operated gates, direct to the ash suction line, as indicated on the drawing. The ash suction line is also connected to the base of each stack to remove any fly ash that collects there.

The boilers themselves are described and illustrated in detail on page 382 of the August 1934 issue in the article "The Integral Furnace Boiler." The boiler is in effect a two drum vertical with the outer tubes extended to form a water cooled furnace. The furnace is fired longitudinally with the drum, the gases of combustion travel the length of the furnace, reverse and come back through the baffled tube section of the boiler to leave at the front end. The Buick boilers are set with the drums at right angles to the firing aisle and each is fired with three burners supplied with coal by a 7½ t. Type B mill, V-belted to a G.E. 125 hp. 440 v. line start induction motor.

Both mills and feeders are on the basement level directly under individual coal hoppers on the firing floor. The arrangement is clearly shown by Figs. 2 and 3. Mills are supplied with preheated and tempered primary air by a Sturtevant size 42-51 fan driven by a 50 hp. G.E. motor, and located on the inlet or supply side of the mill. The fan takes preheated air from the burner windbox and tempering air from the discharge side of the forced draft fan. Each boiler is fired by three B. & W. forced draft circular coal burners designed for an input of 184,600 B.t.u. per hr.

Each boiler has a Ljungstrom air heater located above the boiler and designed to give a preheat of 584 deg. F. at maximum load. Forced and induced draft fans are located on the same floor as the preheater, directly above their respective boiler. Both are Sturtevant driven by Elliott geared turbines. The former have capacities of 47,000 c.f.m. at 11 in. of water and 1756 r.p.m. with 106 hp. turbines, the latter 89,000 c.f.m. at 6.5 in. of water, 375 deg. F. and 870 r.p.m. with 145 hp. turbines. The preheater rotor is driven by a 3 hp. motor through a 200 to 1 gear.

(Continued on page 721)

Emergency Trip

BY H. W. NEWBERGH
Turbine Engineering Dept., Elliott Co.
Jeannette, Pa.

A one act play in two scenes wherein experience gets the new turbine spinning but the governor sticks and even the emergency trip fails to prevent a runaway

SCENE: *Hotel lobby in a small midwestern town, desk with keyrack at the left, entrance to dining room at the right. Large chairs in careful geometrical arrangement, several facing the audience. These chairs supposedly overlook the main street of the town through large plate glass windows. As the curtain rises, The New One, having been carefully trained and on his own on his first large turbine erection job, is waiting impatiently, in somewhat of a panic, the arrival of Big Bill Bush, ace erector of the X Company, who is ostensibly held up between trains on his way East, but actually stopping off to give The New One a leg-up at a critical moment. Time—noon.*

THE NEW ONE (*seeing Bill enter from the side door near the desk*). Oh Boy! Bill, come here so I can kiss you!

BILL. Stand clear, Son, before I strip your blades. Tell me what you're doing so far from home and mamma.

T. N. O. (*very confidentially*). Well, you see, Bill, I didn't do so bad on the course and as a helper in the field, so the Old Man sent me out to erect this new 2500-kw. unit at the municipal plant. You know me, Bill, I'll soon have that baby turning over and purring.

BILL. Fine, son,—nothing to it. Well, I'll be shoving off, just time to catch No. 7 and eat in the diner. Congratulations and good luck. I'll be seein' you.

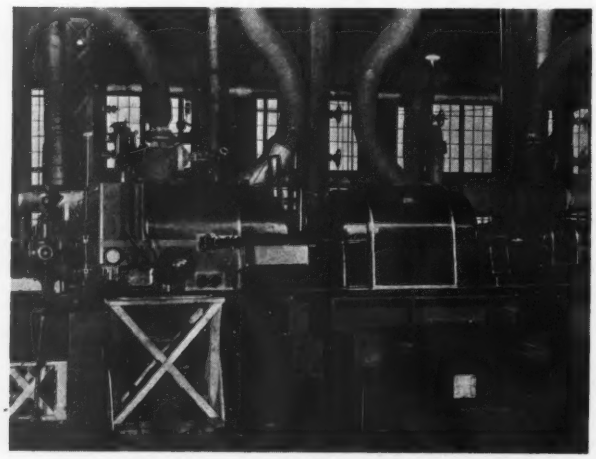

Fig. 1. The shop set up just before the first train ride

T. N. O. (*in obvious distress*). But, Bill! Hold on, wait a minute, Bill! Gosh, Bill, I've got to see you. Bill (*in a complete burst of confidence*), you see I found out today that I'm not as good as I thought I was. There's more to this game than I suspected; in fact, I can't seem to remember the things I learned at all and that unit just has my number. I can't look it in the eye! Bill, you've got to give me a hand or I'm sunk!

BILL. Take it easy, old man. (*Bill extracts a heman watch which he studies carefully.*) Say, I've got a little time between trains, so what do you say we throw on the feed bag and take this thing apart to see what makes the governor go around. (*Both leave through the dining room door.*)

SCENE II: (*Forty-five minutes later, having been supplied with enormous quantities of that which makes an ace erector tick and which was expertly disposed of, they enter from the right.*)

BILL. Well, my boy, let's see just where you are right now, as a starter.

T. N. O. Well, I've been here two days. The foundation is strong and well set—not tied into any building walls or beams, which might cause synchronous vibrations in the building itself—and appears to be in first class condition. Thank goodness I got that condenser, the auxiliary pumps, and the water strainer down under before moving the turbine up. It would be tough to have to move the unit back, if I'd forgotten to put those things in first.

BILL. Fine, old chap! Of course you've got plenty of room to move the turbine through the walls?

T. N. O. Oh, gosh, Bill! I forgot to check that—I can't seem to remember any hole left for that purpose. I wonder if she'll go through that big door near the boiler room end.

BILL (*who knows perfectly well that it will*). Well, that's something to check up first thing, and while you're checking, it would be a fine move to check the foundation against the actual turbine, for, if you have to make any changes, they are a whole lot easier to make before the turbine gets aboard. By the way, what shape is the stuff in? Has the owner adequately protected the unit during storage? You know, son, after all the care we take in shipping this stuff and protecting it, it's up to the owner to see that the good work is carried along during the storage period.

T. N. O. Well, this unit is in a nice place and is well away from the plaster and cement dust of the new addition, and my inspection shows it to be in first class condition. In fact, I should say that this particular owner has assumed his obligation of protection and storage in swell shape.

BILL. Now, then, what about moving her into place, what's your plan?

T. N. O. Well, Bill, I haven't any plan. Just thought we would shove her in.

BILL. Look here, boy—no real erector puts down a skid or hooks on a winch until he knows just what he's going to do every minute. A well conceived and studied plan, executed with deliberation, is the only sure way to a right finish. You see, son, we are one of the steps in the process of manufacture—first, engineering, then shop work and testing, and now installation. What would those birds at the plant think if we bumped or jolted that unit into a bent shaft? What would they say if you forgot to take off that governor rocker arm and one of those laborers bumped it off with a piece of cribbing? What if you didn't wear yourself out keeping those openings covered up and got a lot of sand and grit into the bearings and governor mechanism? Not so good, eh, son?

T. N. O. Gosh, Bill! Hold it until I get out that note book—I know all those things, but somehow they never seemed important until now and you've sure got to be on a remodeling job before you appreciate what a desert sand storm really is. Believe me, I'll check up on those things.

BILL. Well, what are you going to do after checking up tomorrow?

T. N. O. First, a real "go easy" plan, and then I think I'll crib her over to that door. I'm sure now she'll go through all right, and then hook on with the chain fall and lift her into place.

BILL. Not too good, lad,—that chain fall is designed to handle only the heaviest piece during disassembly and can't be used to shift the whole unit or you'll pull her out by the roots, and it would be a fine idea if it fell on your head and straightened it out a bit. Look here, boy, just what is the object of all this fuss anyway?

T. N. O. I have you there, Bill. (*reciting*) "The object of the whole work of installation is to duplicate, as far as possible, the status of the unit as it was erected and operated at the plant of the manufacturer, and to make this status permanent." And, so help me, Pete, I'll go them one better or bust a condenser tube!

BILL. Check and double check—and let those words sink in, my Lad, not just ooze out. Now what was the first step in the shop?

T. N. O. Well, they set the old sole plates up on parallels and shimmed them at the holding down bolts, up to the right height; and leveled the plates in all directions—and I mean, leveled them. Say, Bill, they have a fine accurate surveyor's level here which I think I can get when I come to this part of the work. Of course, I have a dandy spirit level, too, which will be all right if I can't get the other.

BILL. Good boy. Now, of course, the first thing you'll do is get those sole plates on the foundation, and do exactly as they did in the shop. You see, Lad, a sole plate is a kind of chart—the course is marked on it at the shop and if you set it right and follow the course, all of the various parts will fall into their proper relative positions; furthermore, it offers a very satisfactory means of spreading the loads to the foundation. But don't get the idea it's a rigid beam and try to use it for that purpose—it's simply a chart and compression member. What next?

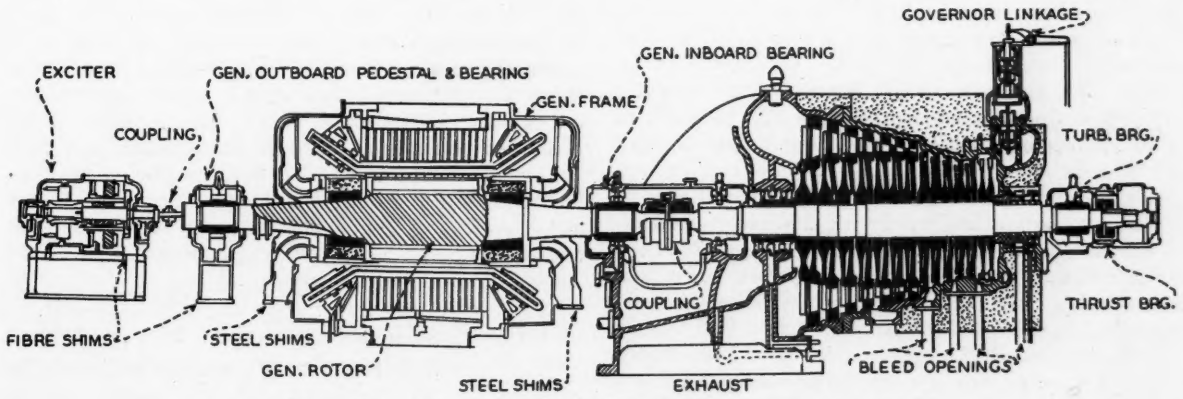

Fig. 2. Cross section of the complete unit, turbine, generator and exciter

T. N. O. Well, Bill, when I have those plates just right and pulled down on flat shims placed near each foundation bolt—I remember the Old Man don't trust beveled wedges for a final setting, as they may creep—I'll throw the old turbine aboard, take off the bearing covers, check my levels at the center flanges both ways and on the shaft at both ends and if the plates are right everything will check O. K. and there we are.

BILL. Suppose the turbine doesn't show level in all directions.

T. N. O. I could shim her up as required.

BILL. No, my boy, we don't shim up to correct warped or badly set sole plates. You'll just go over those plates and do a workmanlike job on them until the turbine does level—O. K., Son?

T. N. O. O. K., Professor.

BILL. Alright, Boy, keep her rolling.

T. N. O. Now let's see, the turbine is up there all Jake, sole plates are level and foundation bolts down tight. Now I put the generator frame aboard in about the right location and follow it with the outboard generator pedestal, which I place to one side. Next up

Fig. 3. Three pages from the life of an erector (left) turbine in cradle ready to be tipped on its side (center) on its side and disappearing through the doorway (right) bottom view, still on its side but ready to be set on the foundation

comes the generator rotor, which must be threaded through the generator frame and I'll be pretty careful not to mar the journals or injure the generator windings during this process. Here's where that "go-easy" plan comes in handy. Now the inboard journal is eased into its bearing, located in the turbine frame, and the outboard journal goes into its bearing in the outboard pedestal all nice and easy and I pause for breath, station announcement, and a little look around.

BILL. Nice going in there, Lad, especially the look around.

T. N. O. And now then, ladies and gentlemen, this is The New One preparing to grapple with that climax of all turbine installations known as "lining her up" or alignment.

BILL. Right you are and that is one of the most interesting parts of the whole job, but before we take on that situation let's crib ourselves over to more comfortable foundations, light off a couple of boilers and take a quick slant backward to see how the job looks from that angle.

(*Having seated themselves near the lobby window which offers a ringside view of any passing pulchritude, Bill extracts his wallet which appears to be a combination of bill fold, safety deposit box, tool chest and picture gallery and prepares to drive home his lessons with a few illustrations.*)

BILL. Exhibits (A), (B) and (C)—(*Shows Fig. 3*) A little job I ran into a few years ago, illustrating an unusual situation—a 40,000 lb. unit on the outside and no opening in the walls to get her into the plant.

Possibility No. 1 was a large window not too far distant, but 10 ft. up and then 20 ft. down to the engine room floor—plenty of cribbing there, I'd say.

Possibility No. 2—Dismantle and re-erect, but no crane or crane service available.

Possibility No. 3—A small door near at hand leading through a narrow hall about 100 ft. to the engine room. Careful measurements indicated this to be the line of march if the turbine was on edge so we cradled her in good stout timbers, up edged her and rolled her into the engine room—7 da. work with five helpers put her on the line—not bad, I thought.

T. N. O. Gosh, Bill, it makes me shiver to think of it.

BILL. All in the game—look here now. (*Shows Fig. 1.*) Here's a picture of a unit like yours all erected in the shop—sole plates just right and wedges up level—everything lined up in good shape. No trick duplicating that set-up is there, boy?

T. N. O. Not for you, Bill, but—

BILL. Not for you either, lad—just a clean cut plan—you know the rest. Here's one showing the unit completely erected (*Shows Fig. 4*), just like yours is going to look when you finish. All neat and clean and orderly and here is a handy cross-section of the works (*Shows Fig. 2*) with the important parts identified. Sweet looking, aren't they? Makes a man feel good way down deep to be a part of this kind of work.

T. N. O. Stop, Bill, or I'll burst into tears. Man, they sure are grand! May I have these pictures, Bill? They'll help a lot when the voltage is down.

BILL. They're yours, Lad. Now about alignment—of course you know that perfect alignment of two shafts exists when the centerline of one shaft extended, in imagination, becomes the centerline of the other shaft. Now then you can get a lot of different kinds of misalignment. For instance, the shafts may be parallel but with the centerlines offset with each other, or the ends of the shafts may center but they may be angularly inclined towards each other in any plane or you may have combinations of these conditions.

T. N. O. Help! Help! I surrender!

BILL. Surrender! Nothing to it! Now line her up!

T. N. O. Well, the inboard generator bearing is located in the turbine frame and this bearing seat is machined at the same time as the turbine bearing seat, so if everything is correctly done the end of the turbine shaft and the end of the generator shaft are definitely centered with each other. Now, since the outboard pedestal is mounted on shims I can move this pedestal sidewise or up and down and it stands to reason that there is one perfect location for this pedestal when the two shafts are absolutely in line. Now, I put the pedestal in such a position that the coupling faces appear to be square with each other and the outer flanges appear to be parallel.

With this type of coupling the hubs are really the flanges so I work on them, marking four points on the outer circumference of each hub equally spaced. Now, since I want to bring the shafts parallel with each other and at the same time correct any angularity that exists, I lay a straight edge on the circumference parallel to the shafts to check offset and measure with feeler or block gauges between the faces at the points already marked. Then I move that old pedestal so that these distances measure alike and the straight edge lies flat on the faces of both flanges and there you are. I'm dead in line!

BILL. Fine as far as you go.

T. N. O. As far as I go! Bill, I'm through! All done! Finished! She's lined up!

BILL. Suppose one or both of the faces of the coupling are out of square with the shaft bore. Then

you've lined the shafts up "out of line"—just like making a perfect aeroplane landing 20 ft. off the ground.

T. N. O. But gosh, Bill, you know our shop doesn't put out couplings like that.

BILL. Of course, I know it, but if some one slips and they do occasionally, I'm not going to let it be reflected in my work. Look here, we start where you left off. Suppose we now revolve both shafts 180 deg. and take readings at the same points as before. If these readings are not the same as the original ones the coupling face or faces are not square with the shafts, are they? So now if, for example, we use the top readings and subtract them, the result will be the amount the faces are out of square in the top and bottom plane across the whole face of the coupling.

Now divide this figure by two and the result is the amount the faces will have to be brought together or spread apart, by moving the outboard pedestal up or down (when the shafts are revolved back into their original position) to bring the shafts in line in this particular plane. In the same way, crosswise readings are taken and the pedestal moved sidewise to give the correct position. Of course all the while you use the straight edge on the outer circumference to check any offset of the shafts. Then the outboard pedestal can be bolted down and doweled with confidence that the two shafts are definitely in line and, by the way, don't forget that one shim under the outboard pedestal and the exciter is made of fibre to avoid stray currents, so don't mix it up with your steel shims.

T. N. O. I'm on the ropes, Bill, but what a system! Takes care of machining errors and—

BILL. —a lot of grief.

T. N. O. Well, Bill, I'm going right into my dance and carry on from there. Next I tackle the generator frame. It's mounted on shims, you know, so I can move it in all directions. My purpose here is to place it so that it is centered magnetically for, if it were not, it would tend to center itself and put a stiff load on the thrust collars. Besides, the air gap has to be properly equalized. This is easy, however, for the shop has provided pin and block gauges for this purpose and all I do is use them as directed. Then I bolt and dowel her down. Next I set up the exciter and line her up just like the generator was lined up and bolt her down. Now the unit is in its final position and I'm ready to grout her in to make this position permanent and allow the loads to be spread through the foundation.

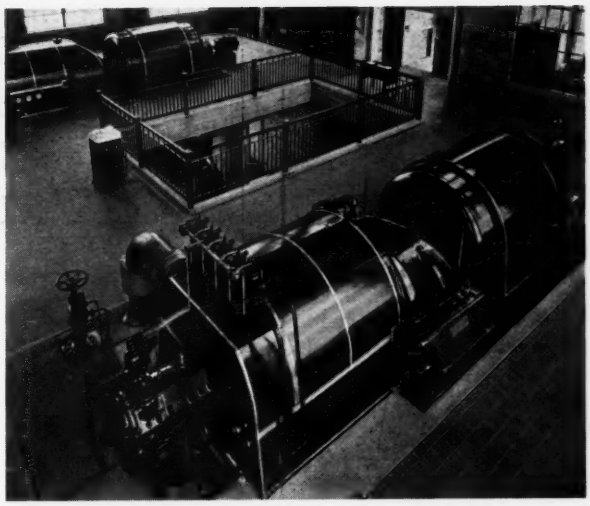

Fig. 4. At maturity—all set and ready to begin a long and useful career

BILL. Go on, go on. This suspense is terrific.

T. N. O. Well, I build a dam from the top of the foundation to the top of the soleplate all around, usually on the outer edge of the foundation, which leaves a space for finish between the soleplate and the rest of the engine room floor. This dam is set level and made tight with stiff cement mortar and then I mix cement and clean sharp sand in the proportions of one part cement and one part sand, by volume, into a rather watery mixture and float it under the soleplates, puddling the mixture through any holes available to make sure that the grout fills all of the spaces between foundation and soleplate. I bear down on this until all spaces are completely filled and the forms are full. Then I finish off the edges and protect them until set, and there we are.

BILL. Well, that's getting pretty well along and I suggest that while you're waiting for that grout to set it would be a good idea to get after the piping. Of course, you'll see to it that the turbine is protected from pipe strains by suitable expansion joints or loops with adequate supports near the turbine. Another thing, be sure that the steam line is well drained near the turbine because we don't want slugs or water to hit the blades when starting up.

Now all the piping and connections are mighty important and you'll have to be very alert on this point

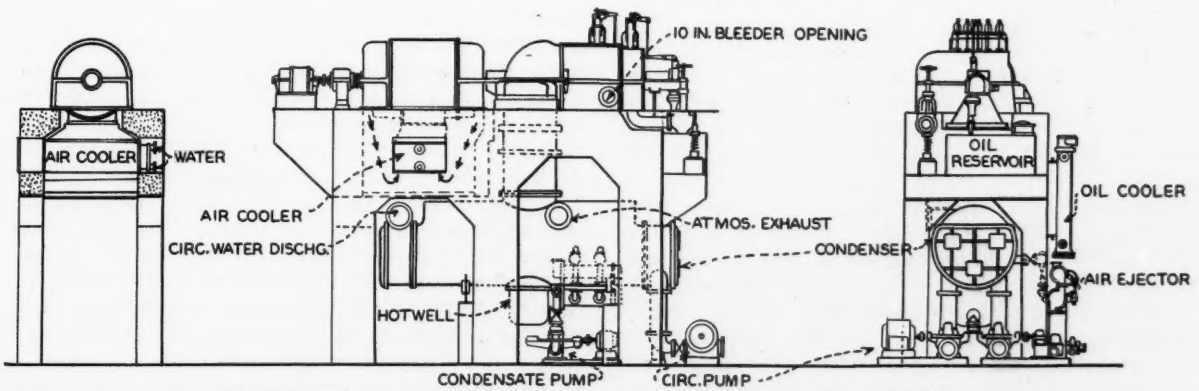

Fig. 5. Complete installation of turbo-generator and auxiliaries on concrete foundation

but especially so on the oil piping because here are the veins and arteries of the circulating system—carrying the lubricating oil which is the very life blood of the unit. Oil piping and passages must be clean and must stay that way. It doesn't take much dirt to ruin a bearing, so you have a real responsibility here.

T. N. O. I know that, Bill, and my system is air tight. First, I blow out all the oil piping with air and plug the ends with cloth plugs and you can be sure I count those plugs just like a surgeon does during an operation so that there's none left inside after installation. Then I go over all the oil passages cast in the unit and carefully wipe them out—examine and clean the working parts of the governor and safety devices at the same time. Then all the lines are put in place and carefully too, for I don't want oil leaks.

When she's all in one piece, I fill up the oil reservoir with the proper grade of oil to a height that will leave a full tank after the piping and oil spaces are full. I am now ready for an oil trial so I take off all bearing covers and start the auxiliary oil pump building up the pressure to its full designed value.

Then I take a good look at the oil flowing through the bearings and let her flush through in this way for about a half hour after which I remove the upper bearing halves and see if any machining chips or foreign material have lodged in the bearing passages. Then I clean everything up in good shape, including the oil strainer, put on the bearing caps and am now ready to give her a whirl.

BILL. Now, I want to be sure you know how to warm up that unit. The ideal condition exists when all parts of the interior are uniformly heated to the maximum operating temperatures existing in the various parts. Unequal heating of any part or concentrated heating, particularly on the shaft or wheels causes unequal expansion of these parts and results in distortion which may result in serious damage if the turbine is rolled over.

You must be sure, then, that a leaky inlet valve is not letting steam pass into the turbine and that steam is not let into the shaft seals until after the rotor starts rolling over. Now, with the steam line well drained and all the drains open, put on the vacuum, start the auxiliary oil pump, give her a shot of steam and get her rolling over at a warming speed of about 500 revolutions. Only then is it O. K. to admit steam into the shaft seals. Then close the various drains and keep her at that speed while you check up on the oil flow and various general operating conditions.

Keep an ear peeled for any unusual noises such as rubbing and if you hear any blue notes shut her down! A half hour of running at the warming up speed will put the turbine in a properly heated condition and this is a good time to try out your safety devices. Trip the throttle valve by hand and try out the low oil pressure device, each time restarting the turbine as quickly as possible so as not to change the temperature conditions too rapidly. With everything going well, bearing temperatures O. K., etc., carefully bring the turbine up to operating speed on the throttle, checking the speed by means of a hand tachometer until the governor takes over control of the turbine. Then open the throttle valve and as you say, there she is.

T. N. O. Yes, sir, Bill, and running like a top. Now, I make a final check on the oil temperature, governor operation and general conditions. When everything looks right I try out that old overspeed trip by carefully overspeeding the turbine by hand. Now, if she trips out and shuts down three times consecutively at the same tripping speed, I figure the trip to be O. K.

BILL. So do I and with all other minor details cleaned up it's time to check up on the wiring and switchboard connections, and give the generator a good drying out run.

T. N. O. That puts the unit in shape to take on its appointed duty. Good design, good manufacture and on the same pedestal—INSTALLATION! and now, Bill (*hurriedly looking at his watch and moving away*), you've saved my life and I'm going to remember you in my will, but you know that swell looking waitress that served us—well . . . .

BILL (*as The New One disappears through the dining room door*). And I thought he needed experience!

Disintegrating the Atom

DUE TO INCREASING IMPORTANCE of high voltages in the field of nuclear transmutations and to gain information as to the production and control of such high voltages, Westinghouse Elec. & Mfg. Co. have now under construction at the Research Laboratories in East Pittsburgh, an electrostatic generator which is designed to attain d.c. potentials of five million volts or more above ground potential. The attaining of such steady voltages above ground, which are several million volts higher than any attained in the past, will enable the research scientists to secure fundamental information in this relatively unexplored field of steady high voltages.

These high voltages are to be reached through the use of a large high-pressure vessel, of shape somewhat similar to an incandescent light bulb, mounted over the roof of a two-story laboratory building. The height of the vessel is 47 ft. and it has a 30 ft. diam. hemispherical portion for the upper part. By means of air under pressures up to 120 lb. per sq. in., it will be possible to maintain steady potentials of five million volts and over on a 15 ft. spherical electrode mounted in the center of the upper end of the tank. These voltages will be reached by using charged rubber belts in the modernized Van de Graaff version of an electrostatic machine. The spherical high voltage electrode, supported by four large micarta insulating columns, is further connected to the lower ground end of the vessel, by means of a segmented porcelain vacuum tube. This vacuum tube contains the lens electrodes which will make possible the focusing of nuclear projectiles on the desired targets. These nuclear projectiles, protons, deuterons and alpha particles are created at the high potential electrode and finally focused into a small target spot about 35 ft. away from the point of formation of the bombarding ions.

The Westinghouse scientists plan to use this high voltage generator in investigations of nuclear reactions throughout the region of available voltages, as it is felt that the steady nuclear beams of homogeneous energy, so necessary in these investigations in nuclear physics, are most readily attainable through the projected design of high voltage equipment.

Coal Characteristics Determine Economical Choice

By ZUCE KOGAN

IT IS NOT always that the coal of low first cost will prove to be lowest in ultimate cost. There are many cases where a good grade of an Eastern Kentucky or West Virginia coal will prove to be lower in ultimate cost than an Illinois or Indiana coal, even though the first cost may be higher.

A manufacturer of metal parts employed in his process around 25 boilers, varying in size from 80 to 400 hp. About 5 of these boilers were fired with oil, the remainder with pulverized coal. Besides these pulverized coal fired boilers they also employed several large heat-treating furnaces, also fired with pulverized coal. The oil fired boilers also had provisions for firing with coal; firing with coal, however, was seldom resorted to because the pulverizing capacity and the storage capacity of the coal bins were low, and for that reason he had to resort to oil firing on these boilers, which were in the order of 300 to 400 hp.

Their yearly coal consumption was 33,000 t. of Indiana prepared coal, and at the rate of $3.75 this amounted to $123,750. Their oil consumption was in the order of 2,800,000 gal., which at the rate of 3.5 cents per gallon amounted to $98,000 per year.

The cost of coal, however, did not stop with delivery cost. To the cost of the coal had to be added the cost of drying, pulverizing, conveying the pulverized coal, and the cost of ash removal. The yearly cost of drying amounted to $3875. It took about 25 kw-hr. per ton of coal for pulverizing and the amount of power consumed to pulverize 33,000 t. per year was 825,000 kw-hr., which at the rate of 0.6 cents per kw-hr. amounted to $4950. Inasmuch as they had a reduced capacity for pulverizing, they had to employ three shifts of labor, amounting to $7200 per year. The cost of conveying coal, which was accomplished by compressed air, was around $500 and the ash removal on the 33,000 t. amounted to about $1000. The actual cost of the coal burning amounted to $141,275. Their total cost of boiler operation, which included the cost of coal and the cost of oil, amounted to $239,275.

After surveying the plant we were convinced that it was too expensive for them to use so much oil on the boilers in view of the fine pulverizing equipment they had.

It was true that the pulverizing equipment was too small for their enlarged needs. We conceived the idea that if we could obtain a coal that would contain more heating units per given weight, less coal would be necessary and hence their pulverizing equipment would be indirectly increased, and thus there would be a possibility for reducing the oil firing.

We scouted around and found a high grade East Kentucky coal. It was 1¼ in. screening and had a heat value per pound of 14,500 B.t.u. as received, an ash content of 3.2 per cent, moisture content of 2 per cent. The coal they were using had a heat value of only 11,500 B.t.u., an ash content of 9 per cent, and moisture 8 per cent. Taking into consideration the B.t.u. value alone of the coal, it was clear that the number of tons of the better coal to replace a ton of the coal they were using would be in the inverse ratio of the respective B.t.u., that is, 11,500 to 14,500, or 0.784. In other words, 0.784 t. of this East Kentucky coal would take the place of 1 t. of their coal as far as the heat value was concerned. Furthermore, the fact that the East Kentucky coal contained less moisture and less ash means the efficiency of burning will be increased, or to be more correct, the losses involved in the burning of East Kentucky coal would be reduced as compared to the Indiana coal. Not taking this into consideration, however, and working on the B.t.u. value alone, the capacity of the pulverizer is increased by approximately 22 per cent (1 — 0.781 or 0.216).

In other words, if they were able before to pulverize 33,000 t. of coal per year, they should be able to do the same thing with the East Kentucky coal. The value of the 33,000 t. of East Kentucky coal, however, would be equivalent to $33{,}000 \div 0.784$ or approximately 42,000 t. of the coal which they were using.

The cost of the coal at their siding was $4.74. After adding to this cost the cost of drying, pulverizing, labor, ash removal, and conveying, the ultimate cost of that coal would be $5.19. Hence, if 33,000 t. of this coal were purchased and pulverized during the year, the cost of fuel would have been $33{,}000 \times \$5.19$ or $171,270.

Inasmuch as the efficiency of burning a pulverized coal and that of burning oil are practically alike, the advantage usually being with pulverized coal, these additional 9000 t. of coal, based on a heat content of 11,500 B.t.u. per pound, are equivalent to 1,380,000 gal. of oil containing 150,000 B.t.u. per gal. the heat content of the oil they were using. Hence, by pulverizing 33,000 t. of East Kentucky coal their oil purchase for the boilers would be reduced by 1,380,000 gal. of oil, and they would only have to purchase the difference between the original 2,800,000 gal. and these 1,380,000 gal., or 1,420,000 gal. At 3.5 cents these 1,420,000 gal. amounted to $49,700. Hence, their total fuel cost, by burning a better grade of coal, would be $171,270 plus $49,700 or approximately $221,000. In other words, they stood a chance of saving in excess of $18,000 per year over their previous cost of fuel.

We presented these figures to the management. These figures were rapidly corroborated by several tests and this manufacturer is now enjoying this substantial saving without any expenditure for new equipment and without any changes in his method of operation.

Smoke Indicates Smothered Fire

Considered from a practical standpoint, the problem of reducing smoke from boiler plants resolves itself into the proper proportioning of air and fuel, intimate mixing of air and volatile gases, and maintaining proper temperature.

By HAROLD M. TOOMBS

TECHNICAL men are well grounded in the principles of smokeless combustion. They, however, are relatively few compared with the many operators who want results first and are content that theories rest until results have been accomplished.

These men handle mechanical coal burning equipment that often is installed with little regard for local ordinances, plant load, stoker design, furnace volume or any of the many other considerations that are so important. Probably the limitation of capital investment was the most prominent thought that guided the hand of the designer.

This is not a plea for the cause of the operating engineer who is handy man for everything electrical and mechanical in the plant and who never has time to supervise anything in the boiler room. An engineer of this type will not admit that his stack smokes. It is not the smoke that he makes himself that bothers him, but the smoke that some other fellow makes. Right there is where the trouble starts with the human equation. Therefore furnaces must be made smoke proof, which is a job that assumes rather alarming proportions.

Books and lectures on the causes of smoke summarize themselves into lack of air, lack of mixture, lack of temperature and lack of space. However interesting that may be, it does not tell us exactly what we want to know and that is just how smoke may be prevented. That is the information they all seem to lack. Only a practical understanding of grates, arches, stoker operation, firing methods, combustion, coal, secondary air, and cleanliness of tube surfaces will prevent smoke nuisance. It is one thing to attain smokelessness and quite another thing to maintain it, which most operating men know to their own discomfort.

Don't Smother the Fire

One word in the English language adequately applies to most of the smoke elimination problems, especially those pertaining to the older types of equipment. That is the word "smother". A smothered fire will invariably produce a murky stack. There may be plenty of draft but when a fire is smothered it will smoke. If a boiler is set right down on top of the grate it smothers the fire and smoke results. When burning refuse in an incinerator, if one load is piled over the top of the other, the fire is smothered, with consequent smoking. The natural laws allowing combustion to take place are broken when the fire is smothered and one of the hardest jobs that the smoke prevention engineers have is stopping just this one thing. Admitting the axiom that a fire needs air to burn smokelessly, why not give it plenty? It is a simple matter to burn coal smokelessly but to burn it smokelessly and economically at the same time is quite a different thing.

A good natural reason exists for this also. Air is a difficult thing to control. It will do anything apparently except what you want. That is the reason that haphazard apparatus purporting the control of air will not work and it becomes necessary to employ especially designed equipment.

The principles upon which smoke may be entirely burned are very plain. The cause of imperfect combustion is a deficient supply of oxygen to the fire at a correct temperature. These two things eliminate smoke—air or oxygen and temperature. If you wish to illustrate this to your fireman, take a piece of foolscap, roll it into a cone with a $\frac{1}{8}$ in. open hole at the apex. Hold it with a knife and light the base of the cone with a match. As it starts burning, smoke will issue from the $\frac{1}{8}$ in. open hole. Light a match and touch it to the smoke. The smoke will burn and entirely disappear as it is consumed. Not only that but it ignites $\frac{1}{4}$ in. away from the apex of the cone and the paper is not even scorched. All of this is elemental but it shows that the reasoning is sound.

Further consideration should be given to the large volume of air needed for combustion. The flame on the cone did not burn at the apex but away from it where there was plenty of air. A volume of air equivalent to two ordinary barrels is required to burn a pound of coal. Practically all engineers have had the experience of coating an old furnace to prevent waste due to air infiltration. The theory is well known. After completing the job the furnace smoked because the fire had become smothered. A few air leaks into the fire box promoted combustion. Ordinarily air infiltration with no pressure behind it carries up the side walls to the roof of the arch. This thought leads to the subject of stratification.

Eliminate Stratification

Stratification is present in most furnaces to a greater extent than is ordinarily realized. Arches, fancy brick forms and other lolytrops will not prevent stratification and perform the intimate mixing or intermingling of the gases with the air that is so necessary for complete combustion. They will change the direction of gas streams but mix—never.

The most effective weapon for introducing secondary combustion air into the furnace, in the opinion of the writer, is the steam jet. Its simplicity has made it its own enemy. Ask any steamfitter and he will tell you that he can build the best jet "you ever seen." If two did not work it was just as easy to stick a

dozen into the firebox. For many reasons the steam jet came into disrepute. A jet to work effectively must be correctly designed, constructed according to sound principles and proper proportions.

Motor driven blowers lack sufficient force to drive the air across wide grates. Individual motors in small sizes are difficult to mount and maintain. Compressed air is entirely too expensive. Thus all things point to the correctly designed jet, one that drives the air onto the fuel bed, and chases it to the point of combustion where it is needed. It is also necessary to move the largest amount of air with the least expenditure of steam. Application of Bernoulli's theorem naturally suggests the Venturi type of nozzle which converts pressure or static head into velocity head or useful work. Just a hole in a piece of pipe will not do this. If a barrel of the jet is rifled the air is thrown into a whirling motion. A jet so designed gives superior results.

Secondary Air Essential

Practical tests indicate that as much as 20 per cent secondary air may be introduced over the fire without lowering the CO_2 because of the complete mixing action. The air is introduced close to the surface of the fire and at a point adjacent to the gate where the distillation of the gases starts. If stratification is to be prevented a constant turbulence must be maintained.

The cross method of firing is used not alone for increasing turbulence but it stops impingement or blowtorch action against the brickwork. By creating a neutral atmosphere, oxidation of the brickwork is prevented, thus materially increasing its life. This economy more than pays for the small amount of steam consumed by the jets.

The brickwork of the furnace should be closely scrutinized for possible improvements. Strange as it may seem, it may contribute its defects to the cause of smoke. A furnace mason does a good job. He will put in all the fire brick that he possibly can and maybe a few more. That is no fault of the mason. Often bridge walls resemble the "Great Wall of China", being 48 in. thick. In reality it is only necessary to have sufficient thickness to prevent flame impingement on the drums. Every unnecessary brick added to the furnace decreases the volume, occupying space needed for combustion. Side walls can often be corbelled back the thickness of a brick. The increased furnace volume will reduce the heat head. This is a self-styled expression for static heat and corresponds to the static pressure encountered in pumping problems. Where the heat head is low, brickwork maintenance is sharply reduced because the soaking action of the heat into the brick is considerably lessened.

The front bank of tubes must be thoroughly cleaned at regular hooking intervals. This will permit stray combustion to take place in the tube bank when running at high ratings. If smoke reaches beyond this point, up the chimney it must go.

At various times it becomes necessary for the fireman to use a slice bar. Perhaps slag stops and adheres to the side wall at the grate line. Then it forms a very ragged fire. Again it will drip and collect in lumps at the bridge wall. When cutting slag from the bridge wall the side door is opened and there is a tremendous rush of cold air into the furnace. All these things increase the hazard of making smoke. To prevent the condition and stop the juggling of 40-lb. slice bars, which is a mean job for one man, water cooled side wall tubing may be used directly on the ledge plates. These may be in circulation with the boiler or the water makeup for the feedwater heater circulated through them. They eliminate the slicing and its consequent smoke. The slag runs down the wall, hits the cold tubing and breaks off into the fire bed and is carried away by the stoker. Burning out of brickwork at the ledge plate ceases. The fires will run true and stretch in a beautiful expanse completely across the grate from wall to wall. Even the front coal gate needs attention because uniformity of fuel and of feed reflects on the smoke problem. These should be leveled off evenly whenever a boiler is down.

Fly Ash and Cinders Present Problem

Tied up closely with the smoke problem is that of fly ash and cinders carried from the stack. Improvement in this may be accomplished by daily or weekly removals from the base of the stack. Regular removals from the rear combustion chamber should be practiced. Metallic baffles inserted between the tubes in the rear pass serve the double purpose of increasing the gas travel across the tubes, thus reducing uptake temperatures as well as doubling the deposit of fly ash in the rear combustion chamber. If it were possible to double the volume of the rear pass of the boiler there can be no hesitancy in saying that the fly ash elimination would be doubled. Very little consideration is given this point even on new installations.

Smoke indicators on each boiler of a battery will show which one is offending. Immediate attention can be given to that particular boiler. An indicator, however, will not eliminate smoke. It is only a tool that assists in the solution of a problem.

On days that are humid and dull, the same rating cannot be maintained with natural draft boilers as on bright days when the barometer reading is high. The same thing applies to seasonal variations. If the boiler is forced beyond its absorbitive capacity the furnace will produce smoke. Adjustment of the gate together with observation of the smoke indicator will lead to the proper setting.

Uniform Fuel Is Essential

Another important consideration is uniformity of coal as well as selection. The fact that oil or gas is burned smokelessly is dependent to a great extent on its consistent quality. For the best results coal as received must be crushed to a uniform fineness. It should then be correctly tempered with a light water spray that the particles are uniformly coated with moisture. Coal that runs first dry and then soaking wet will give the operator trouble not only from a combustion standpoint but increases the smoke hazard.

All of the things causing smoke represent a certain waste and when once waste comes into a boiler room it soon drags in its whole family and all of its wife's relations. They feed at an astonishing rate. Wastes have cats and rabbits backed off the map for fecundity.

Many troubles, for which fans are blamed, originate with the duct design, the inlet box being a frequent offender

MECHANICAL DRAFT TROUBLE SHOOTING

By J. R. DARNELL

FORCED DRAFT fans generally are of the non-overloading type but there may be conditions which cause them to be seriously overloaded.

A small stoker fired industrial plant originally had the forced draft fan placed at the operating floor level but when an air preheater was installed back of the boiler setting a larger forced draft fan was mounted in a small room above the operating floor level, behind the air heater. Air to the inlets was drawn through steel grating in the floor of this room at the discharge end of the fan as shown in Fig. 1, arrangement 3.

It was found that the fan was taking about 20 per cent more power than should have been required while the pressure was somewhat lower. A fan engineer sent to investigate the trouble was unable to decide what was causing the increased power but when he showed the chief research engineer a sketch of the installation, the latter suspected that the air being drawn into the inlets was being given a "spin" in a direction counter to the rotation of the wheel. Such condition would account for the increased power consumption and lower pressure delivered by the fan.

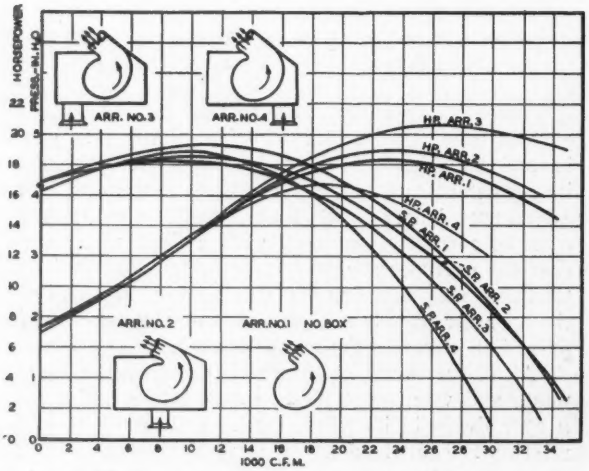

Fig. 1. Effects on fan characteristics of various inlet arrangements

A small test fan of the same type was installed in the fan company's laboratory and a small room built around the fan with the air opening in the floor as shown by arrangement 3. Performance results for horsepower and pressure were as given by curves No. 3. Curves No. 1 show the fan performance with open inlets as ordinarily used for forced draft while curves No. 2 show performance when the fan is used with normally designed inlet boxes or when there are centrally spaced openings in the floor of a small room so that the air enters the wheel without any abnormal spin either with or against the direction of rotation. Curves No. 4 indicate the performance as shown by arrangement 4 where the air enters the room in such a way as to be given a spin in the direction of rotation. This gives power consumption much less than normal but the pressure also is reduced to lower values than with other arrangements, in the normal operating range.

As a result of these tests, operators at the power plant were notified to provide additional openings into the fan room, back of the fan. This counteracted the spin against the wheel, reduced the power and brought the pressure up to curve No. 2.

Duct Work Influences Fan Performance

Once in a large central station in the South an induced draft fan was blamed for reduced boiler output. The fan was sold to deliver 193,000 c.f.m. at 2.52 in. static pressure and take 140 brake hp. but wattmeter readings showed that the fan was only taking about 95 brake hp. and the resistance was only 1.65 in., corresponding to a volume of about 160,000 c.f.m. This

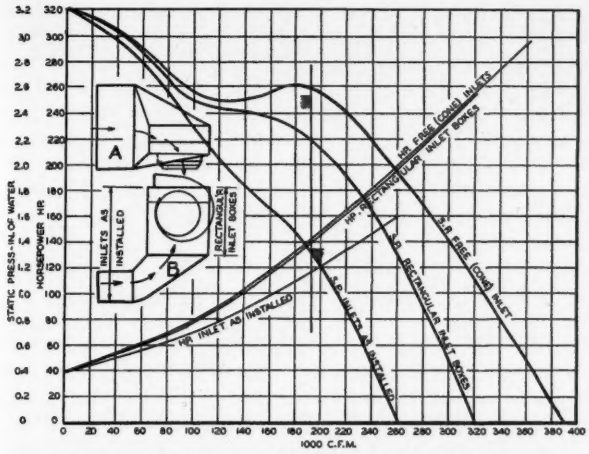

Fig. 2. Results secured from experimental installation

indicated the fan was operating very close to the original system resistance curve and since it was operating at the speed originally specified it was puzzling to understand the reduced pressure and horsepower because the damper was wide open.

Ordinarily, to obtain reduced volumes and pressures when the fan is operated at constant speed, one would have to close the damper partially. But here was a condition where reduced volume, and pressure was obtained in a manner similar to the effect of inlet guide vanes which spin the air or gas in the direction of rotation. A study of the duct system seemed to indicate that the manner in which the flue gas entered the inlet boxes might be causing the trouble for although this fan was of the multi-blade type which is more sensitive to inlet conditions than other types, the peculiar arrangement of the duct work connecting to the inlet boxes would have affected the performance of any type of fan.

After determining these conditions it was decided to duplicate the arrangement of ducts connected to the fan by running a test on a smaller homologous type fan, installed in the laboratory. Figure 2 shows the results obtained with this fan after translating these results to the size fan used at the power plant, at the same speed and temperature. Diagrams A and B to the left of Fig. 2 show how the gas entered each of the inlet boxes of the test fan shown in Fig. 3. A is the plan view and B is a side elevation of one inlet box.

As actually installed in the field the air entered the inlet boxes from the bottom as shown in diagram B in Fig. 2 but for practical purposes when running the tests in the laboratory air entered the boxes at the top as shown in Fig. 3.

The angular duct connections at the entrance to the inlet boxes which had the effect of giving the gas a velocity of spin in the direction of rotation of the fan blades, caused a reduction in the effective maintained resistance developed by the fan, reduced the power and also the volume handled due to the fact that the force which the fan exerts on the flue gas or air is dependent upon the relationship between the velocity of the fan blades and the spin velocity of the air or gas. As this spin velocity approaches the blade velocity the fan becomes less effective in exerting force on the air or gas.

Faulty Economizer Casing Design Causes Trouble

Another striking example of the effect of duct connections on fan performance was found in a large eastern industrial plant where the induced draft fan as in the majority of cases, was unjustly blamed for curtailed boiler output. Draft readings taken through the boiler setting gave about normal results although the candle test showed somewhat more than the usual leakage between the drum and the brickwork. But this, however, was not the chief cause of the trouble.

When I first started to look over the installation I had noted that the economizer which was installed with two banks of horizontal tubes, appeared to have a very small connection at the top for the passage of the gas from the first to the second bank. After checking the draft loss through the boiler setting I directed my attention to this economizer for I believed that this was the source of the trouble. Draft readings soon confirmed this belief. As shown in Fig. 4, flue gas from the boiler setting entered the first bank at X at the bottom, passed upward and after making a 90 deg. turn, passed downward through the second bank leaving at Y. Draft readings showed an excessive resistance from A to B. The amount was almost equal that from X to A or from B to Y. Construction drawings showed there was about 18 in. clearance between the tubes and the top of the economizer casing. Since this top was of the double walled type, filled with insulating material it was decided not to discard it but to raise it up and then provide a filler piece between the top and the side walls. The casing width for each bank was 42 in. and in order to allow the gas freedom to turn with the least amount of resistance there should have been a height of 42 in. allowed between the tubes and the top of the casing. But it was found that an 8 in. steam line overhead would not permit raising the top more than 20 in. I believed, however, that this would

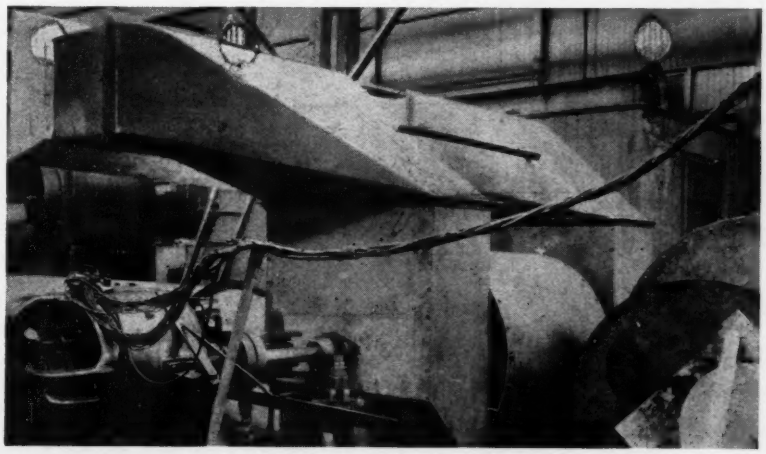

Fig. 3. Experimental fan installation in laboratory

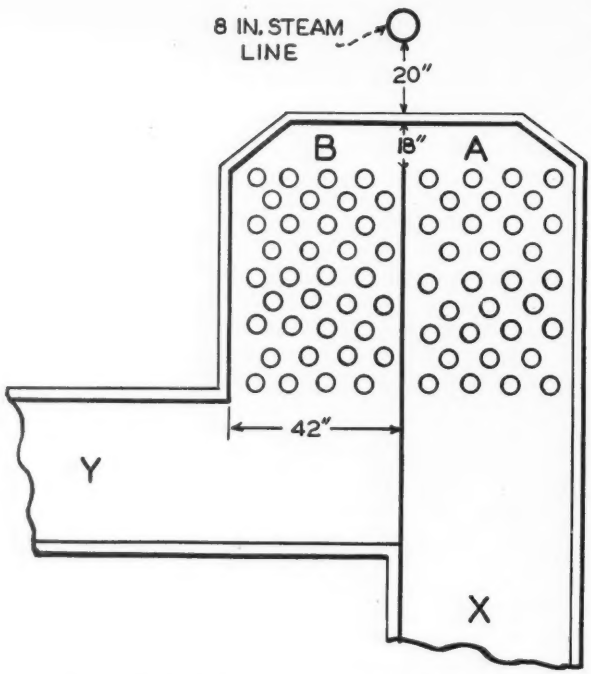

Fig. 4. Obstructed gas passage curtailed boiler output

give satisfactory results and after the top was raised, draft readings showed such a decreased resistance that there was no difficulty in bringing the boiler up to the maximum desired load.

Afterwards, in discussing the matter with the draftsman who had designed the economizer casing he said he thought he was making the space above the tubes ample because he had made the free area in the center equal to the free area through either of the tube banks.

Air Must Have Ample Space for Turns

Air or gas although classed as a fluid is not like water or oil which are practically non-compressible. Air, when striking an obstruction in its path of flow will become partially compressed at this point and the amount of flow will be much more retarded than would water under the same conditions. A simple illustration of the action of air particles in making a right angle turn as in the foregoing case is to think of a column of soldiers marching five abreast. If the man on the outside of the turn is to keep abreast of the others without losing step and dropping behind he must have an unobstructed path in making his turn. Figure 5 illustrates this action. Air particles in making a 90 deg. turn in a duct do not travel in lines corresponding to arcs of circles—the turn is not smoothly rounded but is more nearly square. This is why there is less resistance if the duct is made rectangular at the turn instead of being rounded as shown by the dotted line.

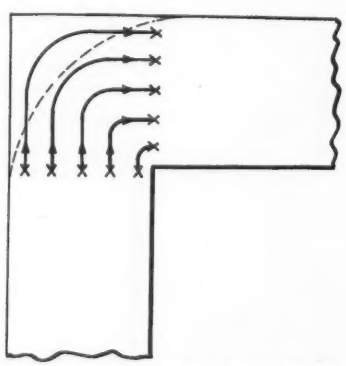

Fig. 5. Path of gas particles making 90-deg. turn

Duct Connections to Air Heater Reduce Boiler Output

On another occasion, I was called to an industrial plant to investigate the cause of curtailed boiler output after an air heater had been installed. Two boilers operating in battery as shown in Fig. 6 had been connected to an economizer with straight rows of vertical tubes. An air heater of the plate type was later purchased and installed in a horizontal position. The forced draft fan was located directly beneath the heater with the air entering and leaving at the bottom through the openings as shown by the dotted lines.

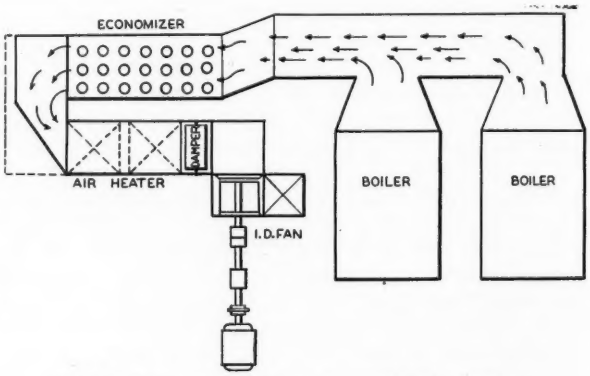

Fig. 6. Enlarging duct at turn improved boiler capacity

Draft readings taken at various points in the path of gas travel from the boilers to the induced draft fan showed an excessive drop in the 180 deg. turn between the economizer and air heater. It was obvious that here again was a case where the gas didn't have room to turn although the free area in the turn was equal to the free area of the gas passage through the air heater. After the duct was enlarged as shown by the dotted lines, the boilers delivered the desired steam load without difficulty.

Fluctuating Draft Causes Trouble

One of the strangest cases of freak fan performance was found in a central station in the South. The plant was provided with six boilers with one held in reserve. Each boiler was provided with forced and induced draft fans. The boilers were oil fired with the forced draft ducts leading to the burners from beneath the floor.

At the time I was called to this station a severe flood had just receded and the forced draft ducts were full of water. This necessitated the opening of inspection doors in front of the burners so that the induced

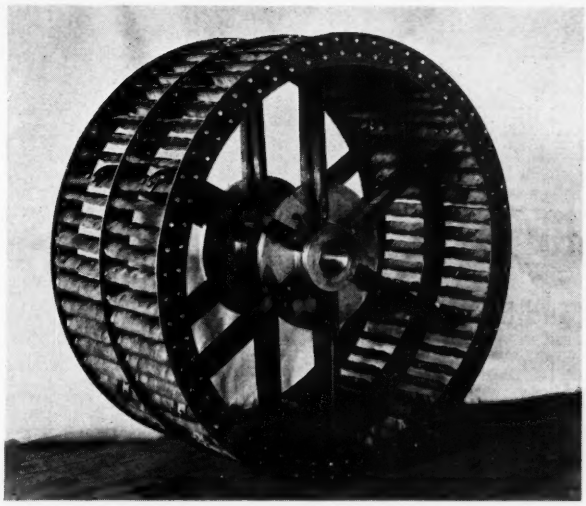

Fig. 7. Fan wheel of forward curve multi-blade type

draft fans could draw in the necessary air for combustion. This worked satisfactorily on four of the five boilers needed for operation but for some strange reason the draft in the furnace of number two boiler fluctuated so much that the burners could not be kept ignited.

I spent three days taking draft readings and studying operating conditions but could not determine what was wrong with the induced draft fan on this boiler. At first I thought the burners were at fault but when these were exchanged for others which had been giving good results on another boiler, the same difficulty was experienced. There was no excessive resistance at any point in the system and there was no loose damper, the oscillation of which might have caused the draft fluctuation. What then was causing the trouble?

Just when I thought I would have to concede defeat something told me to check the dimensions of the cut-off. It should be explained that in fans with wheels of the forward curve multi-blade type, as shown in Fig. 7, the discharge area in some cases is reduced by a curved piece of sheet metal bolted to the scroll so as to overhang the wheel, as shown in Fig. 8. This is known as the cut-off. The action of forward curved blades in wheels of this type of fan is such that the rotational component of the velocity of the air leaving the wheel actually is greater than the peripheral velocity of the wheel itself. The insertion of the cut-off piece in the outlet reduces the discharge area so that the expansion beyond this point will convert velocity pressure to static pressure.

Measuring the length of this cut-off piece showed

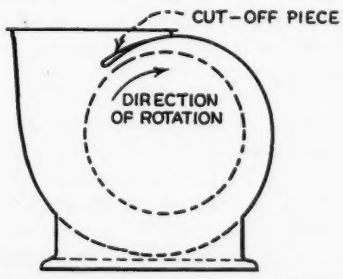

Fig. 8. Location of cut-off piece that eliminated fluctuating pressure

that it was 3 in. shorter than specifications for this size of fan. There was nothing to lose by trying a longer cut-off so I went out to a scrap pile back of the plant and found a piece of No. 16 gage sheet metal which, after being cut to the proper dimensions, was bent double and slipped over the end of the cut-off and bolted to it so as to provide a 3-in. extension.

Longer Cut-Off Stops Fluctuation

The fan was started up cold and the draft gage connected to a nipple fastened to the inlet box showed no sign of fluctuating suction. The trouble appeared to have been overcome but it still remained to be seen what would happen when the burners were operating and the boiler put on the line. I almost held my breath until this was tried but the draft still remained steady and the Chief offered his congratulations for finding the answer to the puzzle.

Explanation of this phenomenon probably may be found in the supposition that, with the longer cut-off, expansion to the full area of the discharge duct took place farther away from the wheel so that eddy currents which had set up fluctuating back pressure were eliminated.

Federal Power Commission Plans

Announcement is made of provision for close cooperation between the Federal Commission and State regulatory commissions by special procedure in cases where both bodies are interested. Suggestion for joint hearings or reference to a board may be made by either body by giving notice to the other, decision as to desirability of such meeting resting with the Federal Commission. For a board meeting, one or more state commissions may send such members as the Federal Commission may specify, each state to have equal representation unless it voluntarily waives such equality. When the board has been selected, the matter in hand will be referred to it by the Federal Commission, powers of the board defined, rules of procedure established and time and place of the hearing fixed. Findings of fact and law with recommendations will be submitted by the board to the Federal Commission.

Joint conferences or hearings of Federal and State commissions may be held on request of either body, representation of the state being as for a board hearing. It would seem that, in any case, final decision as to disposal of the matter will rest with the Federal Commission, but every opportunity will be given state representatives to present their views.

Because of the added work involved, regional offices of the Federal Commission have been established, the administrative head of each such office being an engineer known as Regional Director, with the necessary engineering, accounting and clerical staff. Such offices are: In New York, Old Court House and Post Office Bldg., headed by Robert H. Barclay; in Atlanta, 10 Forsythe St., headed by Major A. R. Wellwood; in San Francisco, Phelan Bldg., headed by E. W. Kramer; in Denver, Central Savings Bank Bldg., headed by Lester S. Wing. It is expected that an office will be established in Chicago on or before Dec. 1, 1936.

OXYGEN Removed by Chemical Means

By R. M. Hitchens* and R. W. Towne*

Mechanical deaeration is often followed by chemical treatment to remove the last traces of oxygen. Sodium sulfite has been widely used for this purpose and the following tests give data on its rate of reaction with oxygen

CORROSION OF IRON due to oxygen dissolved in water has long been a serious problem. Efforts to remove dissolved oxygen, especially in steam boilers, have been directed along two lines—the mechanical method and the chemical method. Mechanical deaeration, the most widely used method, is the most economical for the removal of the bulk of the oxygen and at the present time is often supplemented by chemical deactivation to remove the last traces of oxygen.

Sodium sulfite, which combines readily with oxygen to form sodium sulfate, is now employed extensively in this connection. This is not a new process, having been patented in several countries in 1913 by Gans. It is only within the last four years, however, that its commercial application has become extensive.

Sodium sulfite offers advantages for removing oxygen from water. It is economical, easy to apply and easy to control by simple analytical tests. It is soluble in water and is oxidized to water-soluble sodium sulfate, the presence of which in boiler water has been considered an asset.

Experimental Work

Fears that sodium sulfite would hydrolyze at boiler temperatures to form sulfur dioxide which might be carried over with the steam have proved groundless. The present authors have demonstrated the complete absence of such carry-over of sulfur dioxide at low pressures. A central station company has proved the absence of sulfur dioxide in the steam from boiler water containing 100 p.p.m. of sodium sulfite at temperatures corresponding to 1200 lb. per sq. in. pressure.

The chief questions regarding the use of sodium sulfite have pertained to its rate of reaction with dissolved oxygen and to completeness of the reaction. The present investigation was undertaken for the purpose of obtaining under a variety of conditions laboratory data concerning the rate of reaction of sodium sulfite with oxygen dissolved in water.

Reaction between pure sodium sulfite, dissolved in pure water is immeasurably slow, if it occurs at all. The reaction does not proceed at a measurable rate unless a catalyst is present. The catalysts for this reaction are the cations of the heavy metals which show more than one valence. Although considerable work has been carried out on the rate of the reaction, practically none of it can be utilized to predict how rapidly and how completely sodium sulfite will remove oxygen from water.

In this work it was planned to study the rate of reaction of sodium sulfite with dissolved oxygen at 15 deg. F. intervals from 10 to 85 deg. C. These experiments were to be carried out with the addition of the theoretical quantity of sodium sulfite to remove all of the oxygen and also with the addition of both a 20 per cent and a 100 per cent excess of this reagent. Since there is ample evidence that the reaction is affected by the type of water used, it was decided to carry out experiments in water from different sources.

Distilled water was chosen as a type containing but minute traces of impurities, both catalytic and inhibitory. St. Louis, Mo., city water was chosen as a second type after examination of several natural and boiler waters had shown it to exhibit a marked retarding effect upon the reaction. Atlantic Ocean water, collected several miles out from Boston, Mass., and shipped in glass containers, was chosen as another type since previous experiments had shown it to exercise a marked catalytic effect.

Since expense precludes the practicability of using chemically pure sodium sulfite for removing oxygen from water and since small amounts of metals such as would be present in the technical material enhance the reaction rate somewhat, it was decided to use a technical grade of sodium sulfite throughout this investigation. Comparison of the results obtained using the same sample of water under identical conditions showed that this technical product reacted with dissolved oxygen about ten per cent more rapidly than did chemically pure sodium sulfite.

Test Data and Discussion

Results obtained by this procedure using distilled water are shown graphically in Fig. 1. Tests were run at 10, 25, 40, 55, 70 and 85 deg. C., but data are included for only those temperatures where the results are measurable.

Figure 1 (a) contains the data obtained when sodium sulfite was added in the exact amount required

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From a paper presented at the 39th Annual Meeting of the A.S.T.M.

to react with all the oxygen present in the water. It will be seen that the reaction is only moderately rapid at 10 deg. C. but that it is accelerated rapidly by increasing temperatures until, at 55 deg. C., oxygen removal is practically complete in 1 min. and at 70 deg. C. is complete in 30 sec. At 85 deg. C. it is too rapid to measure. It is undoubtedly complete in much less than 30 sec., which time interval is the shortest in which the reaction can be started and stopped with any accuracy. Thus an indicated reaction time of 30 sec., may mean that the reaction is complete in less time.

Figure 1 (b) shows that a 20 per cent excess of reagent almost doubles the rate of reaction. The reaction is now complete in 7 min. at 25 deg. C. It is practically complete in 30 sec. at 55 deg. C. At 70 and 85 deg. C. it is too rapid to follow. Figure 1 (c) shows that addition of a 100 per cent excess of reagent results in another substantial increase in the rate of reaction. At 10 deg. C. the reaction is complete in 10 min., at 40 deg. C. it is complete in 1 min., and at 55 deg. C. it is complete in less than 30 sec. The accuracy of these determinations is about plus or minus 2 per cent up to 40 deg. C., plus or minus 3 per cent at 55 and 70 deg. C. and plus or minus 4 per cent at 85 deg. C.

Results obtained using St. Louis city water, chosen for its marked tendency to inhibit the reaction, are shown in Fig. 2. Figure 2 (a) gives the results obtained with the addition of the theoretical quantity of sodium sulfite. The reaction is extremely slow at 25 deg. C., slow even at 40 deg. C., begins to speed up distinctly at 55 deg. C., is reasonably rapid at 70 deg. C. and is complete in 2 min. at 85 deg. C. Apparently it is only about one-tenth as rapid as in distilled water under the same conditions.

Figure 2 (b) shows that with a 20 per cent excess of sodium sulfite the reaction is still slow at 25 and 40 deg. C. The rate increases markedly at 55 deg. C., at 70 deg. C. the reaction is complete in 4 min., and at 85 deg. C. it is complete in a little over 1 min. Although the excess of reagent apparently exerts little effect at the lower temperatures it causes an appreciable increase in the rate of reaction at 70 and 85 deg. C.

Figure 2 (c) shows that even with a 100 per cent excess of reagent the reaction rate is slow at 25 and 40 deg. C. At 55 deg. C. reaction is complete in 5 min. At 70 deg. C. it is complete in 2 min. and at 85 deg. C. in 30 sec. Thus even in a water which shows strong inhibitory tendencies the reaction still proceeds rapidly at 70 and 85 deg. C. when an excess of sodium sulfite is used.

Data obtained using sea water are given in Fig. 3. It will be observed that the reaction is so rapid that the temperature scale has been doubled in plotting the data. Figure 3 (a) shows the results obtained with the addition of one equivalent of sodium sulfite per equivalent of oxygen. Even at 10 deg. C. the reaction is complete in 4 min., at 25 deg. C. in 2 min. and at 40 deg. C. in slightly more than 1 min. The reaction is over five times as fast in sea water as in distilled water.

Figure 3 (b) shows that with a 20 per cent excess of sodium sulfite the reaction is complete in 2 min. at 10 deg. C. and in 1 min. at 25 deg. C. Figure 4 (c)

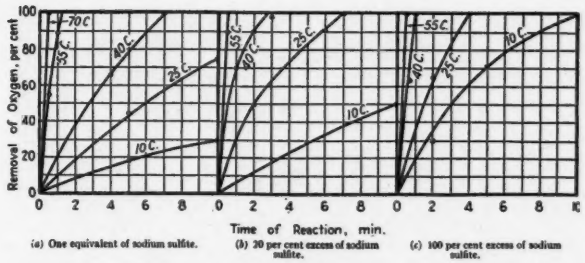


Fig. 1. Test results using distilled water, pH value 7 to 8

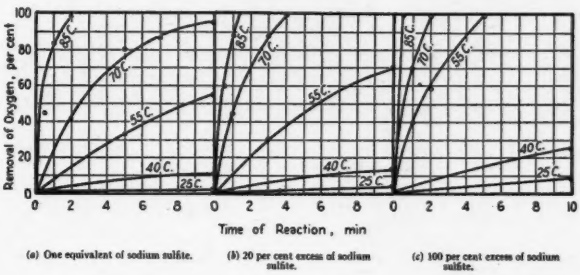


Fig. 2. Test results using St. Louis City water, pH value 9.0

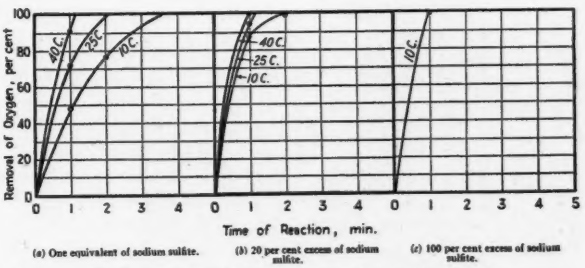


Fig. 3. Test results using sea water, pH value 8

shows that in sea water with a 100 per cent excess of sodium sulfite present the reaction is complete in 1 min. at 10 deg. C. The experiments on sea water were among the first carried out. In that stage of the investigation the technique had not been developed sufficiently to permit the observation of reaction periods of less than 1 min. It is, however, obvious from the results that the reaction must be almost instantaneous under some of the conditions studied.

This investigation of the reaction between sodium sulfite and dissolved oxygen shows that the reaction rate is a function first of the type of water, second of the temperature and third of the excess of the reagent employed. The reaction proceeds roughly five times as rapidly in sea water as in distilled water and ten times as rapidly in distilled water as in St. Louis city water. The reaction proceeds with great rapidity at 85 deg. C. even in water with strong inhibitory tendencies. In general, a rise of 10 deg. C. doubles the speed of the reaction. A 20 per cent excess of reagent almost doubles the rate of reaction and a 100 per cent excess almost quadruples it.

It is felt that this investigation, carried out on waters of divergent properties over a wide temperature range and with various proportions of sodium sulfite, lends support to the belief now prevalent among many engineers, that sodium sulfite is an effective means for the removal of oxygen from boiler water.

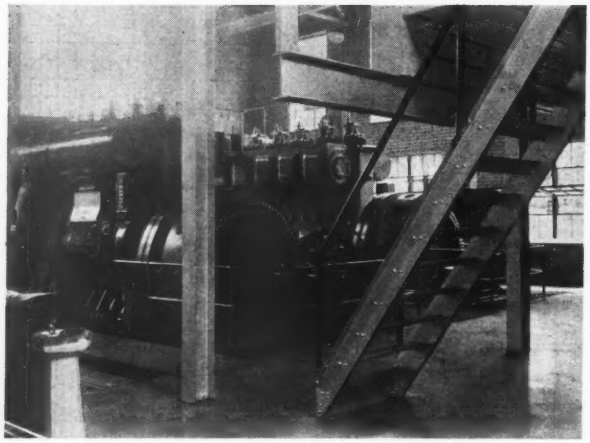


Fig. 1. Two Busch-Sulzer two cycle engines driving G.E. 600 kw. generators are installed in the new plant

Sturgis

Michigan city supplements hydro-station output by new Diesel station with two 600 kw. units.

FOR MANY YEARS the city of Sturgis, Mich., has owned and operated a municipal electric distribution system and waterworks. Part of the electric power has been purchased from a utility highline and part supplied from a municipal hydro-electric plant located about 18 mi. northwest of the city and containing two 600 kw. Allis-Chalmers water wheel units. Of recent years low water has increased the proportion of purchased power to such an extent that the city this summer installed two 600 kw. Diesel units completely rebuilding for this purpose an old steam plant in the center of the city. At the same time the water works was revamped and two motor driven deepwell pumps installed. The wells are 160 ft. deep.

The first engine was put on the line late in July, before the completion of the station as a whole, carrying practically full load. Both engines are 5 cylinders, 15⅛ by 21 in., two cycle, solid injection Busch-Sulzer Type 5SE21 and each engine drives a 600 kw., 2400 v., 3 ph., 60 cycle, 0.8 p.f. Type AT1-24 General Electric generator. Exciters, V-belted to the generators, rated at 15 kw., 125 v. d.c., 1450 r.p.m., were also supplied by General Electric. The engines are equipped with Woodward Type IC governors and Bosch fuel pumps.

The General Electric switchboard with two generator and 9 feeder circuits is equipped with G.E. current relays, recording voltmeter, synchronizing panel and voltage regulator. The recording kv.a. meter is Westinghouse. Circuit breakers are G.E. remote controlled type, which with the field rheostats are installed on a balcony above the switchboard. Station auxiliary and lighting transformers are installed in the basement. The first consists of three single phase 25 kv.a., 2400 to 120 v., and the second one 10 kw. Line Materials Co. units.

Control board, shown at the end of the main switchboard, is for both the water works and station auxiliaries. The left hand section consists of a Marsh pressure gage recording the water main pressure, a Republic flowmeter and alarms to indicate low pressure. The right hand panel indicates low lub oil, starting air and jacket water pressures, and high jacket water temperature for both engines. In the center is a multipoint Alnor pyrometer for exhaust gas temperatures and the bottom rows are the push buttons for auxiliary motors driving the raw water pump, treated water pump, spare pump and lubricating oil pump for units No. 1 and No. 2. In addition, each engine has a gage board indicating the lub oil, piston cooling oil, starting air, jacket water, scavenging air pressures and the fuel oil pressures to and from the strainer. Temperatures are indicated by Tag indicating thermometer installed where needed and convenient for the operators. The engine room is served by a Richards-Wilcox 3 t. hand crane.

Inasmuch as the water is hard, a closed cooling water system is used. City water is treated by a Warbo

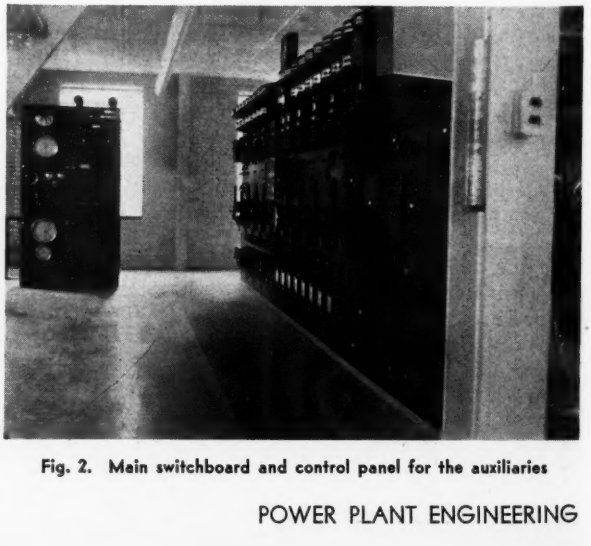


Fig. 2. Main switchboard and control panel for the auxiliaries

Turns to Diesel Standby

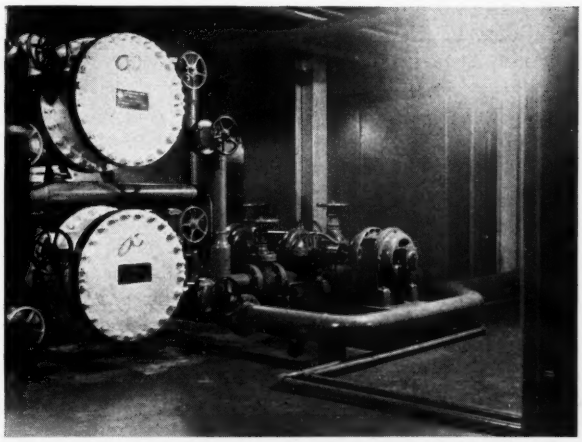


Fig. 3. A closed cooling water system is provided. The soft water storage tanks are visible in the background

softener and stored in a treated water tank immediately below the engine and visible in the background of Fig. 3. From this tank a treated water pump, with a capacity of 350 g.p.m. against 70 ft. head and driven at 1750 r.p.m. by a 10 hp. motor, takes its suction and pumps through Griscom-Russell multiwhirl heat exchangers to the engine jackets.

A raw water pump, 350 g.p.m. against 50 ft. head and driven at 1750 r.p.m. by a 10 hp. motor, takes its suction from the base of the Marley cooling tower, shown by Fig. 4, and pumps through the heat exchangers to the top of the tower. A third pump, a duplicate of the treated water pump, is piped and valved so that it acts as a spare for either. All three pumps are Dayton-Dowd driven by General Electric motors with G.E. magnetic starters.

Piping is completely welded and color coded, red for raw water and yellow for soft water. The color does not, however, extend to the entire piping. It is confined to the valve flanges and handwheels, giving an unusually neat appearance and differentiating the different systems as distinctively as a solid color.

Lubricating oil for the engines is pumped by a Goulds Model 335 Hydroil unit, driven by a 1 hp., 220 v. G.E. motor and is pumped to the engines by a Viking pump driven by 3 hp. motors. Lubricating oil from each engine is cooled by an Andale size 60.6 oil cooler. Socony-Vacuum Gargoyle DTE, B.B. is used for this purpose.

Outside underground oil storage is provided by two tanks, one 20,863 and the other 10,944 gal. capacity. They may be filled either by truck or from a nearby railroad siding. Both tanks have heating coils. From these tanks the fuel oil goes through a Goulds Hydroil unit and is stored in a 1538 gal. clear oil tank, also outside. From this tank the oil is handled by Viking pumps to individual 250 gal. elevated tanks for delivery through Hauck and Curio filters to the transfer pump on the engine.

Starting air is supplied at 250 lb. by a Worthington vertical compressor close belted to a G.E. 7½ hp., 1750 r.p.m. motor and a G.E. magnetic starter and Trumbull Type C safety switch. The compressor has a Burgess intake filter and in case of power failure the V-belts may be switched to a Novo engine mounted on the same base.

The entire plant is well designed from both an engineering and architectural standpoint and fits in well with the surrounding buildings. Being near the center of town, safety, noise and vibration have been considered. The engines are equipped with centrifugal spark arrestors and mufflers. It is also a standby plant for the hydro station and as water is usually sufficient to carry the load during the cooler months of the year, a small oil fired boiler is being installed in the station for heating.

L. C. Waterstrout is city manager and city engineer and J. J. Threlfall is chief engineer of the plant.

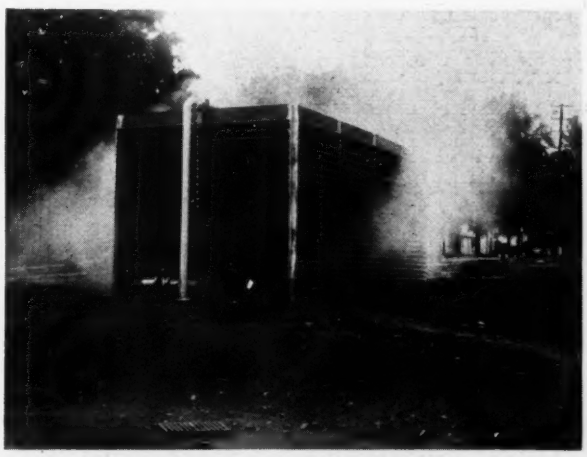


Fig. 4. The raw water is cooled in a Marley tower

Lubricants should resist changes in viscosity, carbon content and acidity during operation the author tells the A. S. M. E. at Ann Arbor

Diesel Lubricants

By C. M. LARSON
Supervising Engineer, Sinclair Refining Co.

WHEN judging performance of lubricants used in solid-injection Diesel engines, certain definite designs and operating conditions imposed on the lubricant have to be considered. The lubricating system of today is of the dry sump type, one pump circulating oil to the bearings and cylinders and another suction pump returning the oil to the supply tank. The same oil, therefore, lubricates the bearings and the power cylinders. In the majority of designs, the viscosity requirements set by various Diesel engine manufacturers are 400 to 780 sec. Saybolt Universal at 100 deg. F., as shown in Fig. 1, area A. Winton, however, is restricting their circulating oils to area B, which is limited by 1000 sec. viscosity at 100 deg. F. maximum and 75 sec. at 210 deg. F. minimum.

Oils covered by area A consist of those ranging from Gulf Coast, through Mid-Continent, Mid-Continent solvent treated, to Pennsylvania, while area B is comprised of selected Mid-Continent, Mid-Continent solvent treated, Pennsylvania and Pennsylvania solvent treated oils. The trend on the Winton is toward the mildly solvent treated Pennsylvania oil of 85 to 95 sec. at 210 deg. F. with the 1000 sec. viscosity at 100 deg. F. maximum maintained.

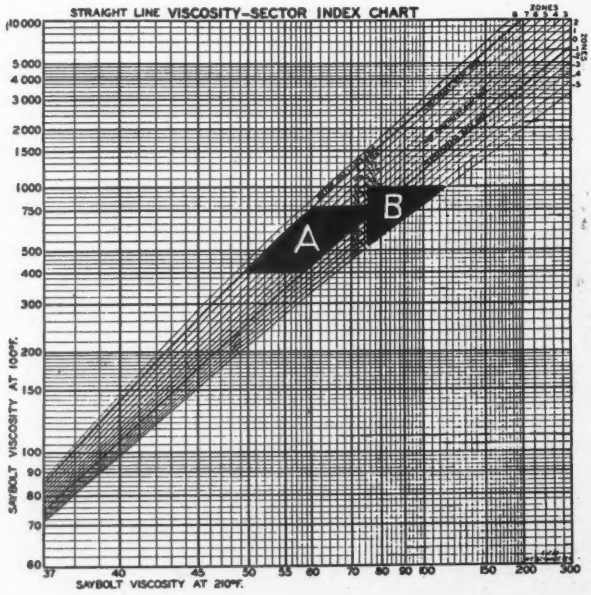


Fig. 1. Viscosity range of lubricating oils recommended by most engine manufacturers falls within area A

Rate of Circulation

In circulating systems, oil escapes from the bearings and is whipped into a fine spray. The hotter the oil and the more it is whipped into hot air or blow-by gases, the greater the oxidation and sludging of the oil. The rate of oil circulation and capacity of the system regulates the amounts of heat absorbed or removed. Naturally the engine, with one gallon per 6 hp. rated capacity with the same rate of circulation and operation conditions, will impose less hardship on the oil than the same engine with one gallon per 10 hp. In several instances, where it was impossible to increase oil capacity, excessive sludge trouble was eliminated by increasing the rate of circulation and putting in an oil cooler. The increased rate of circulation of cooler oil reduced the piston and ring temperatures so that less oxidation and cracking of the oil occurred and the blow-by was reduced because better piston seal was maintained. Formerly, heavier oils were tried but the condition became worse because of the higher temperatures and the more sluggish oil flow.

High end point, high carbon content or low ignition quality in a fuel has a great deal to do with excessive sludge in the lubricating oil, due to slow or faulty combustion and cracking of the heavy ends. Figure 2 shows a plot of spontaneous ignition temperature against the average boiling point of different fractions of petroleum oil which gives a theoretical insight into drastic change in characteristics of the heavy fractions of a petroleum distillate. The sharp turn of curve at 700 deg. F. indicates that such fractions do not burn completely and crack into fine carbon which blows by the pistons into the circulating oil.

In addition to this, consider the increased pressure caused by poor ignition quality fuel (low Cetane Number) as shown by Fig. 3. The rough running fuel raised the maximum pressure to 1056 lb. at full load or 266 lb. higher than the smooth running fuel. The part load maximum pressure was also greater than the full load with the smooth running fuel. The blow-by for such rough running fuel is increased several fold and, where this is coupled with high end point, much soot passes the rings into the crankcase. If the shocks are too great, the bearings have been known to pound out.

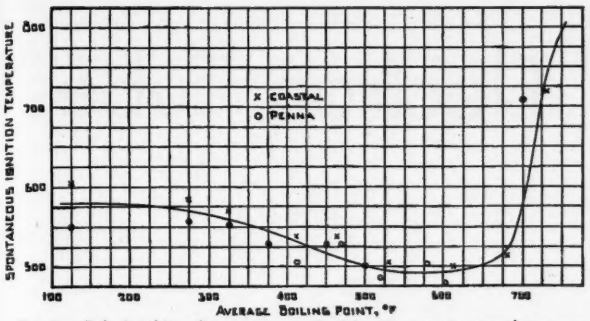


Fig. 2. Relationship of spontaneous ignition temperature and average boiling point of different oil fractions

An analysis of circulating oil, complained of as giving bearing trouble, showed: Oil, 98.5 per cent; sludge (volume method) 1.5 per cent. When the oil was separated completely by a 6000 r.p.m. centrifuge, it reverted to virtually its original state: Viscosity at 100 deg. F., 520 sec.; viscosity at 210 deg. F., 56; neutralization No., 0.13 mg. KOH; precipitation No., none; carbon residue, 0.10; ash, none.

Service Studies

When the 1.5 per cent sludge was analyzed, it revealed the following: Oxidized oil (asphaltic) by weight, 10.33 per cent; iron oxide, 8.80 per cent; iron sulphide, 11.37 per cent; carbon (piston blow-by), 69.50 per cent; reaction to water, acid.

Examination of the fuel showed that the sludge was caused by the 730 end point and 37 Cetane number, and, the high acid and iron sulphide by the high sulphur content of 1.51 per cent in the fuel. When the fuel was changed to a 600 end point product with a low sulphur content of 0.25 per cent and a 55 Cetane number (the engine operating at 900 r.p.m.) the bearing trouble disappeared and the sludge condition was greatly reduced even though the drainage periods were greatly extended.

Viscosity of the circulating oil increases with use due to oxidation. Never does dilution occur except where the fuel injection plungers are tied into the circulating oil system and plunger leakage takes place. Every precaution should be taken to prevent the entry of water into the circulating systems. Water in the oil not only increases the frictional resistance, causing the oil film to break down prematurely, but also corrodes the journals.

Excessive deposits in piston ring grooves interfere with the functioning of the rings. The rate of deposit varies with each particular engine. The basic principle is to reduce this to prevent the aggregate of carbon from forming. This can be best accomplished by keeping the temperature of the pistons below the cracking point of the oil and allowing enough lubricating oil to pass the top ring to flush the blow-by carbon from the ring grooves. Here again the high end point of the fuel which is slow burning and cracks into fine sooty carbon and tarry matter will increase the rate of ring sticking.

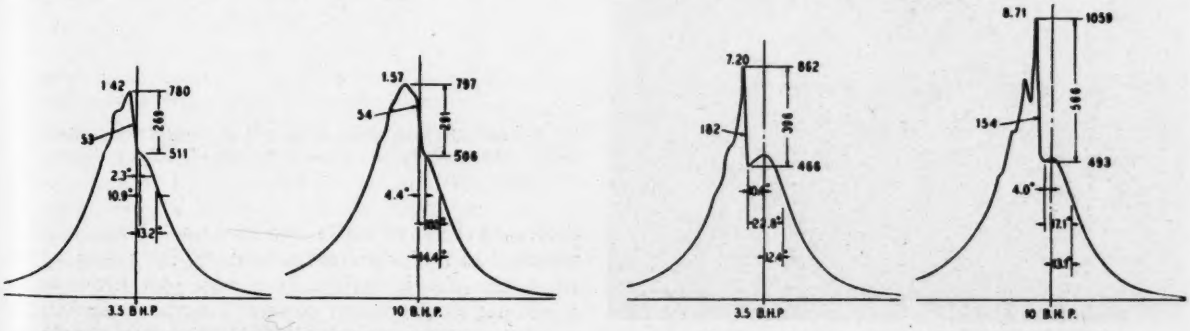
In a few instances, where the temperature of the rings was sufficiently high to crack the lubricating oil or even where circulating oil temperatures were extremely high, ring sticking was overcome by the addition of a small amount (two per cent or less) of carbon disintegrator material to the lubricating oil. This kept the carbon aggregate from building up into a bricquette. It is too early to say how extended this addition agent will be used in large industrial Diesel engines.

Leakage of the gases past the split of each piston ring and more especially past the clearance between each ring and its groove causes pressure to build up behind the rings. Behind the top ring this pressure is greatest, being approximately one hundred per cent of the pressure on the piston. The pressure behind the second ring is approximately eighty per cent. Behind the last ring it is practically negligible. The upper rings produce squeezing action which greatly reduces the oil film. The lubricating film on the upper portion of the cylinder wall is subjected to higher temperatures for longer periods in addition to high ring pressures. This top portion of the stroke wears greatest. This is clearly shown by the measurements of a high speed Diesel engine liner in the accompanying table.

Summary of Diesel Engine Liner Wear Data

Distance from Top of Piston in Inches	Longitude Wear per 1000 hours	Trans. Wear per 1000 hours
1 1/16	0.0025	0.0029
2 1/16	0.0010	0.0014
6 3/4	0.0008	0.0014
10	0.0010	0.0014
12 3/4	0.0004	0.0008

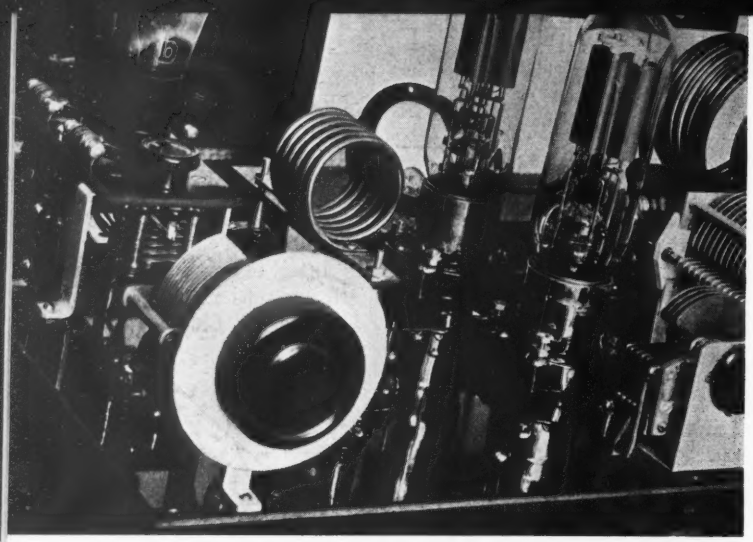
Performance of lubricants in Diesel engines is so interrelated with combustion efficiency and lubricating oil stability, that it is difficult to isolate them. In so far as the lubricating oil can be considered a contributing cause, however, if a lubricant is used which resists to the greatest degree possible any change in viscosity, carbon content and acid number during operation, then the user is assured that troublesome asphaltenes will not develop to cause sludging in the crankcase and sticking of piston rings and valves.



SMOOTH RUNNING – FUEL 57 CETANE NUMBER

ROUGH RUNNING – FUEL 31 CETANE NUMBER

Fig. 3. Cards taken from a 10 hp. single cylinder 4¼ by 6 in. four cycle engine at 1200 r.p.m. for smooth and rough running



Electron Tubes

PART XI

THE ABILITY of the electron tube to generate electrical oscillations from direct current, we have seen, arises directly from the amplifying property of the tube. It is an important and valuable function of the tube since it provides a means of generating alternating currents of any frequency with purely stationary apparatus. Its most important application in this respect is in the radio communication field where it is used to produce the high frequency currents (from 20,000 to 500 million or more cycles per second) necessary to effect efficient electromagnetic radiation. It can, however, just as easily produce frequencies of much lower orders for industrial purposes and, while the oscillator has not come into wide use in industry, some applications of it have been made. In this article we shall consider the mechanism of oscillation in somewhat greater detail.

An electron tube oscillator as was shown in the preceding article is simply a self-excited amplifier. An impulse delivered to the input side of the circuit is amplified, part of this amplified impulse in the output side of the circuit is then fed back to the input side and the process repeated. The circuit, therefore, supplies its own input.

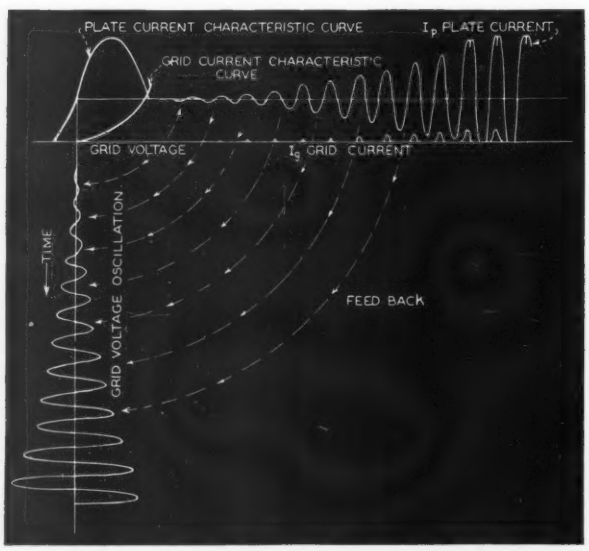


Fig. 1. Diagram showing how oscillations are built up in an electron tube circuit

Suppose, for example, that 1 milliwatt (.001 watt) is required to excite the grid of a triode amplifier and that the tube has a power amplification of 100 times. The power in the plate circuit, therefore, will be 100 mw. Any circuit, however, possesses resistance and such resistances introduce losses which appear as heat. Suppose these losses in this case amount to 50 mw. This represents half the power in the plate circuit, so 50 mw. remain to be used for other purposes. By coupling the plate circuit to the grid circuit some of the output voltage excites the grid and if this is in the proper phase to add to the original exciting voltage, this new additional voltage will be amplified and some of it will again be returned to the grid circuit. This current which is fed back from the plate circuit has the effect of neutralizing some of the resistance of the circuit.

Now, of course, we know that resistance is a property of the circuit and, as such, it cannot be neutralized. If resistance could be neutralized, however, the effect would be, with a given voltage, to increase the current.

This is exactly what occurs in the oscillator circuit. The feed-back has the effect of increasing the current; therefore, we can regard it as neutralizing the resist-

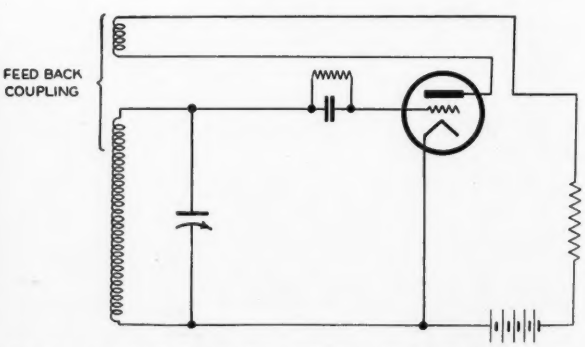


Fig. 2. An inductively coupled oscillating circuit. This is the same circuit that was shown in the preceding article

ance. As the coupling is increased and more energy is returned to the grid circuit, finally there comes a time when the virtual resistance is zero—all losses being wiped out by the output power. From that time on the circuit continues to "oscillate." This is no violation of the principle of the conservation of energy—we are

—Principles and Applications

Further considerations of oscillator circuits

By A. W. KRAMER

not "getting something for nothing"—but the extra power is derived from the batteries in the plate circuit.

This process of building up oscillations is practically instantaneous in ordinary circuits. It may take but a few cycles to arrive at the oscillating condition and since the frequency usually is very high—millions of cycles—the actual time of building up is very small. Theoretically, oscillations cannot start unless some initial disturbance starts the first cycle in the grid circuit, but in any practical circuit there are plenty of disturbances. The mere snapping on of the plate voltage or the shaking of a tube is sufficient to initiate the action. The slightest change in the grid circuit produces a corresponding but amplified change in the plate circuit. This change continues in the same direction as far as the characteristics of the tube and the con-

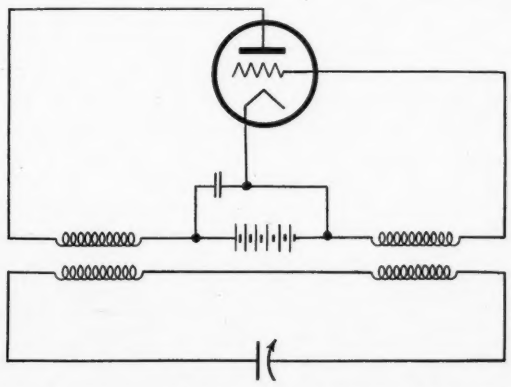


Fig. 3. Another form of inductively coupled electron tube oscillator

stants of the circuit will permit. When the current is increasing, the change continues until the plate current reaches its saturation value. In the opposite direction, or toward less plate current, the change continues until the anode current reaches zero. As the limit is reached in each direction successively, the trend reverses. Thus, the current oscillates about the nominal d.c. value of anode current to which the tube is biased.

The mechanism of building up oscillations is illustrated graphically in Fig. 1. In this diagram the plate and grid current characteristics of the tube are shown in the upper left hand corner. The grid voltage oscillations are shown directly below. By projecting values of this grid voltage to the plate characteristic and then projecting at right angles in the manner described in Part IV,[1] the corresponding plate current variations are plotted horizontally at the right. A small impulse

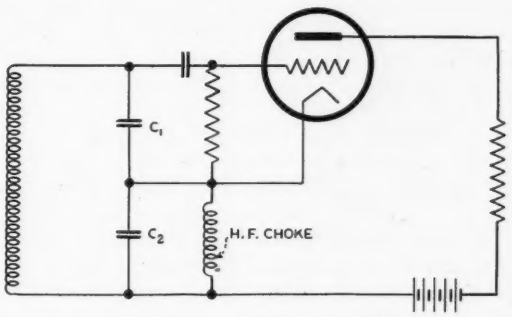


Fig. 4. A capacitively coupled oscillator circuit

in the grid circuit produced a similar larger impulse in the plate circuit. This in turn produces a slightly larger impulse in the grid circuit and the oscillations build up until an increase in grid voltage no longer increases the pulsating current in the plate circuit owing to the fact that the plate current can neither pass below the zero line[2] nor increase above the saturation value. The oscillations are then maintained at constant amplitude.

It is possible to build circuits in which oscillations build up slowly but as a rule circuits are too willing to oscillate and elaborate precautions often are necessary to keep amplifiers from "winding up" and breaking into continuous oscillation.

[1] Pages 284-288 of the May 1936 issue.
[2] Because of the unilateral conductivity characteristic of the tube.

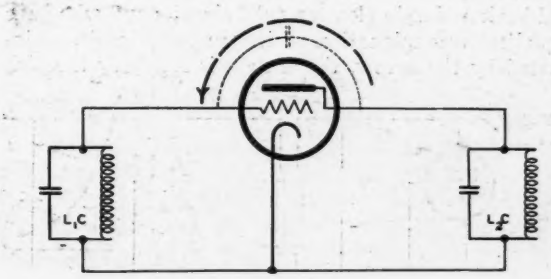


Fig. 5. The tuned grid, tuned plate circuit which uses the inter-electrode capacity of the tube to effect coupling between input and output circuits

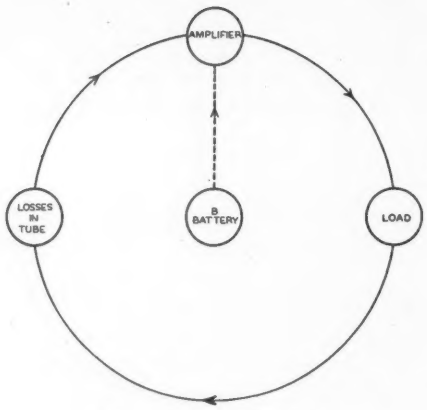


Fig. 6. The oscillating cycle.

This more or less "natural" tendency of electron tube amplifiers to oscillate may not be apparent from the circuit we have considered, Fig. 2. For unless the "feed back" arrangement is purposely introduced how is the energy from the plate circuit transferred back to the grid circuit?

This is a logical question. Its answer lies in the fact that the feed-back coupling may be effected in a number of ways. The inductive method in Fig. 2 is only one of a number of arrangements. The "feed back" can be accomplished just as easily by capacitive coupling, i.e., by the use of a condenser. Various inductive methods are possible. In Fig. 3, for example, is a slightly different arrangement from that in Fig. 1 although in principle it is exactly the same. Here the coupling is effected through a separate circuit which is coupled inductively to both the plate and grid circuits of the tube. In Fig. 4, the coupling is effected by means of the voltage developed across a small condenser C_2. The power is extracted by the grid circuit by the voltage across C_1. With this type of circuit the direct current power furnished by the plate battery is connected in series with a high frequency choke coil (HFC).

If Fig. 4 is examined closely, it will be noted that both condensers C_1 and C_2 through which the feed back coupling is effected are in parallel with the tube elements. The tube elements themselves, however, constitute the elements of a small condenser and it is easily conceivable that if the capacity formed by the grid and plate electrode is great enough, the coupling condensers could be dispensed with entirely. This actually is the case in the Armstrong tuned-grid-tuned-plate circuit shown in Fig. 5. This is one of the circuits invented by E. H. Armstrong who first studied the feed back action in electron tube circuits and who gave a qualitative explanation of it. In this circuit, as indicated by the arrow, the energy is fed back through the capacity effect of the tube itself. When the natural frequency of both resonant circuits LC_1 and LC_2 are adjusted to the same value, the maximum energy transfer takes place because with those conditions the voltages developed across these circuits will reach their highest values.

Now it becomes evident why it is so difficult to prevent oscillations from building up even in circuits that are not specifically designed for this purpose. For if the tube itself can act as the coupling device it naturally becomes difficult to avoid the condition. This difficulty increases as the frequencies involved become higher because at high frequencies the capacity effect of the tube elements becomes increasingly greater.[3] At the high frequencies used in radio, the capacity effect of the tube elements becomes so marked that special methods for neutralizing these capacities become necessary. These will be described in later articles.

The essential principle in all of these arrangements, however, is the same whether the energy is fed back through the tube by condenser action or through separate condensers or coils. This principle may be made clearer, perhaps, by means of the diagram shown in Fig. 6. Here the flow of power can be traced. Coming originally from the B battery or other source of direct current power in the plate circuit, part of it is absorbed by the load and the rest is dissipated in the tube itself. Once started, the energy travels around the (vicious) electrical circle shown and the oscillations build up until the limit of the tube's capacity is reached.

In any case, the load circuit usually contains an inductance and capacity which determines the frequency of the generated oscillations. It is by suitably proportioning these constants (inductance and capacity) that the frequency of the oscillations is determined and as already pointed out by this means frequencies from those of less than a cycle per second to those of millions per second can be generated. In radio work, the function of the oscillator is primarily to supply currents of frequencies of millions of cycles per second to the transmitting antenna.

As pointed out, however, the oscillator can be used to supply high or low frequency alternating current for any other purpose. In industry it is used to a certain extent for the inductive testing of metals, in electric furnaces, where the high frequencies required cannot economically be produced by rotating machinery. The oscillating tube is also used for control purposes.

An excellent example of the oscillator tube as a control device is in a system of leveling control for electric elevators. In this system, shown in Fig. 8, the

[3] The capacity reactance is equal to $\frac{1}{2\pi fC}$ in which C is the capacity of the condenser in farads and f is the frequency in cycles per second.

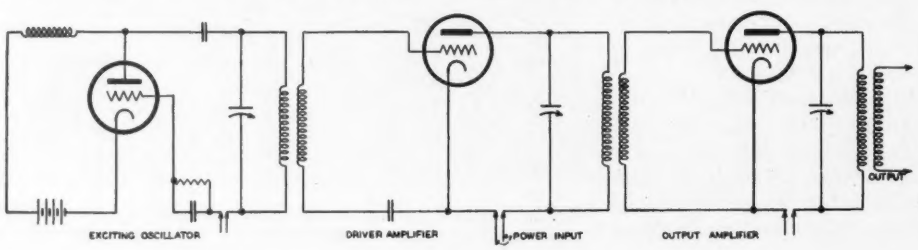


Fig. 7. Oscillator-amplifier arrangement for producing oscillations of great magnitude

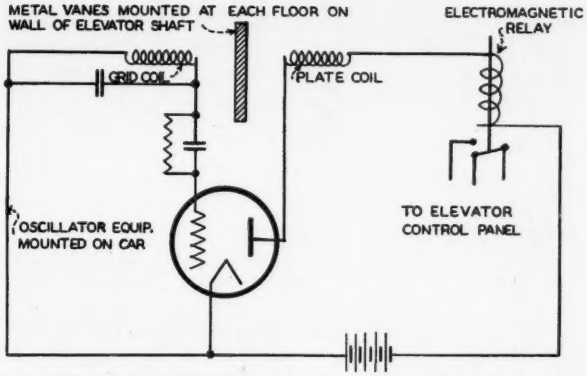

METAL VANES MOUNTED AT EACH FLOOR ON WALL OF ELEVATOR SHAFT
ELECTROMAGNETIC RELAY
GRID COIL
PLATE COIL
OSCILLATOR EQUIP. MOUNTED ON CAR
TO ELEVATOR CONTROL PANEL

Fig. 8. Oscillator control circuit for electric elevator leveling control

oscillating circuit with the plate and grid coils are mounted on the elevator car. On the walls of the elevator shaft, at each floor, metal plates or vanes are mounted so that as the elevator passes the floor one of these plates passes between the plate and grid coils. Normally the circuit is in an oscillating condition. As the elevator passes a floor, however, the metal plate comes between the coils and the feed-back action is stopped, since the metal plate acts as an effective shield against the electromagnetic transfer of energy. As a consequence the plate current falls, which actuates the relay and this sets in motion the control equipment which brings the elevator to the exact position required with respect to the floor.

Any electron tube oscillator may be used to excite other amplifiers. When high power output is required, it is usual to produce oscillations by means of a small tube and of relatively low power. This oscillator is then coupled to succeeding amplifiers consisting of larger tubes which amplify the weak oscillations produced by the oscillator. By arranging a number of amplifying stages in "cascade" in this manner it is possible to produce high frequency currents of hundreds or even thousands of kilowatts. This is the method used in all broadcast and high power radio transmitting stations. It may also be used for industrial furnace work. A simplified diagram of such an arrangement is shown in Fig. 7. In this diagram at the left is shown a simple oscillator of the type we have considered. This is magnetically coupled to an intermediate amplifier which amplifies the weak oscillations produced by the oscillator. This intermediate amplifier in turn is coupled to a final output amplifier in which the oscillations are again amplified and delivered to an output circuit.

New Insulation System for G.E. Motors

A NEW "BUILT-FROM-THE-INSIDE-OUT" insulation system developed by the General Electric Company and applied to its general-purpose line of random-wound squirrel-cage polyphase induction motors, according to G-E insulation engineers, is based on a new philosophy in their field of endeavor. The philosophy is the outgrowth of a thorough-going analysis which they recently made to determine the relative importance of each component in a random-wound motor assembly. F. P. Wilson, Jr., assistant head of the G-E insulation engineering department, discusses their findings and describes the new insulation system as follows:

"Our studies revealed that the enamel film on the conductor exerts the greatest influence on coil life. In recognition of this fact, various means of improving the quality of the enamel film and better methods of handling the enameled wire during assembly operations are incorporated in the new system of insulating the random windings. As a result, an insulation assembly is produced with high resistance to moisture and other common deleterious influences such as mild acids, alkalis, oil, and abrasion, and the need for taping the end windings is eliminated.

"Double-enameled, bonded-cotton- or paper-covered wire is employed for the stator coils. The film of enamel on the wire is applied in such a way that its thickness, hardness, flexibility, resistance to solvents and heat shock are accurately controlled. The cotton or paper covering acts as mechanical protection for the enamel during assembly of the coils, and the bonding prevents the covering from sliding on the smooth enamel.

"After assembly, the stator undergoes a dipping procedure which utilizes a new varnish of the synthetic-resin type having high penetration, retention, and bonding-strength properties. A special baking process is used and through it the time of exposure of the insulated assembly to elevated temperatures is reduced by as much as 75 per cent. Following the baking period the end windings, instead of being taped, are given an application of tough, hard, oilproof and abrasion-resisting Glyptal, a G-E alkyd-resin product.

"The special baking process was adopted because heat ages insulation, as is recognized by the establishment of the A.I.E.E. temperature limit for organic insulating materials at 105 deg. C. maximum. Since it is necessary to use temperatures above 105 deg. C. in baking insulating varnishes of the modern type, the reduction in the time of exposure to elevated temperatures, which is made possible by the new process, assures potentially longer life of the insulated structure as regards its tendency to heat-age."

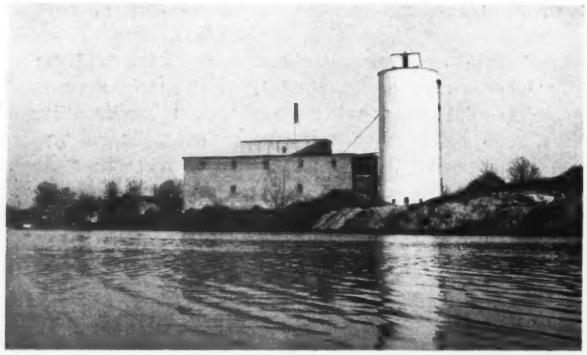
Wage Adjustment

WHILE SURVEYS of wages paid at various General Electric Co. plants show, as stated by President Gerard Swope, that the Company is paying at least as high as community rates for like skill and efficiency, and that weekly wage of employes has somewhat more purchasing value than in 1929, yet a plan has been adopted to compensate for increase in cost of living as shown by figures of the U. S. Department of Labor. As hours increase up to the standard 40 hr. a week, wages increase and as the Company's profits increase, distribution on the profit-sharing plan increases, so that, recently, hourly rates and weekly earnings have risen faster than cost of living. To allay concern, however, the plan provides that as cost of living rises, increase will be made in employe earnings up to 10 per cent above the present level, and when that point is reached, the question will again be given consideration. If cost of living decreases, adjustment will be made downward but not below the standard of earnings now in effect. On this basis, 2 per cent was added on Oct. 1 to weekly or monthly earnings on the first $3000 per year of all those receiving not over $4000 a year.

A. C. Supercedes D. C. in Reopened Malt House

After 15 years of inactivity, plant at Waterloo, Wisconsin resumes operation with new electrical system using municipal plant power

By
K. B. Humphrey



FIFTEEN YEARS AGO the Malt House owned by the Interstate Malt Company at Waterloo, Wisconsin, shut down. Today it is running again, but with many improvements and increased capacity. All of the old direct current motors have been taken out and junked, except for two emergency motors, and 440 v., 3-phase, alternating current motors have been substituted. Altogether about $7,000 have been spent on the electrical system. The power was formerly furnished by two steam driven 220 v. generators and a waterwheel unit. Now the power is purchased from the local municipal plant and a 440 v. a.c. generator has been connected to one of the old waterwheels. The old system was out of date and would not have furnished enough power, and there would have to be considerable investment in new boilers, engines, etc., hence the decision to purchase the bulk of the power.

There was a little salvage value in the old system and wherever possible conduit and boxes were used. The old engine room was the logical place for the main distribution point as the electric power line was near at hand. The 2300 v. power system is stepped down to 440 v., 3-phase, an ungrounded system being used. All the switches are of the safety type. The main switch has a capacity of 400 amp. and is fused at 300 amp. giving ample capacity for future additions. From the main switch conduit connects two of the old salvaged boxes which contain the current and potential transformers for the meters. The metering equipment consists of a power meter, a reactive component meter and a demand meter. All of the power wiring is in conduit and the various circuits are taken off through fused safety switches. There are three main power circuits which can be called A, B, and C. A has a connected load of 101½ hp., B has a load of 83 hp. and C a load of 17 hp. making a total of 201½ hp. In almost every case the old drive was used with some modifications to suit the new speeds used. Some of the machinery was speeded up in order to get more capacity. The old d.c. motors totaled only 163½ hp. and in the old installation the pumps were driven by steam.

The old lighting system was 220 v. d.c. and most of the lighting feeders were taken off the motor power lines for each section. In the new system a 7.5 kw. single phase air cooled transformer is connected across one phase of the 440 v. power line stepping the voltage down to 220-110 for the three wire system. The whole lighting system had to be revamped and made to comply with the code. In some places new wiring had to be installed while in other places some of the old system could be used. Open wiring was used in places on account of moisture, but wherever the wiring

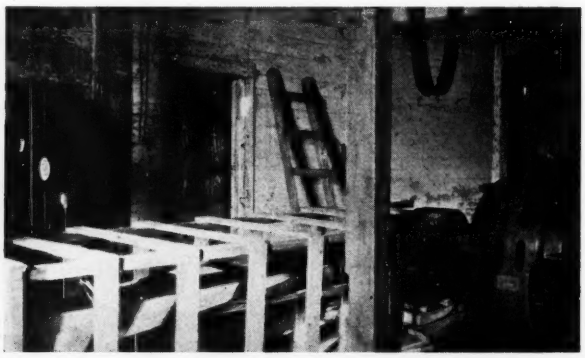


Fig. 1. The 440 v. generator driven by a cross belt from a vertical water wheel generator

came down to switches or within reach conduit was used. Some BX was used in the elevator, and where some new concrete tanks were put up the conduit was placed in the concrete. The lighting system was one of the first things to consider because during construction work it furnished current for electric drills and extension lights wherever repairs were needed.

Old Generator Used In Power Factor Control

The power contract with the village requires that a power factor of 80 per cent be maintained at all times. The 60 kw. 440 v. generator is operated with an over excited field and helps keep it up, but as there is not enough water to operate continuously so some other means had to be provided. A 30 kv-a. capacitor was installed so as to float on the line at all times. The average power factor runs well over 90 per cent with this arrangement. In operating the generator, the speed is regulated by hand until synchronism is reached and then the machine thrown on the line. The gates are then opened wide and the generator allowed to pull all of the load it will. The variations are taken by the purchased power. No trouble has been experienced in synchronizing and

Fig. 2. The service switch and metering arrangement. The old D.C. switchboard is shown at the left

as the unit is located in an old mill at some distance from the main buildings it receives, and requires, very little attention. About 40 kw. can be obtained and is a real saving. The number of kw-hr. generated depends a good deal on the water available from the river, but usually 5000 or 6000 kw-hr. can be depended upon and of course during the Spring much more will be generated. The other waterwheel is connected to one of the old direct-current generators and as the wires are in place it is an easy matter to rig up so that two of the fans can be run by direct current should there ever be an emergency when they are needed. With the outlined arrangement it is possible to insure against a complete shut down. If the purchased power should give out the generator would furnish enough power to keep some of the machinery in operation until repairs could be made.

Recirculation in Skimmer Type Dust Collectors

By Louis C. Whiton, Jr.
President Prat-Daniel Corp.

ONE of the methods which is now extensively used for the separation of dust from flue gas, consists of first concentrating the dust along the periphery of a circular passage; then passing a portion of the gas containing the concentrated amount of dust through a skimmer and into a cyclone for precipitation of the dust from this gas. The amount of by-passed gas containing most of the dust varies between 10 and 20 per cent, depending upon the operation of the apparatus.

The effective overall efficiency of this type of skimmer dust collector depends upon the efficiency of separation in the preliminary circular or scrolled shaped passage, and the efficiency of collection in the cyclone itself.

If the dust leaving the cyclone is passed to the outlet of the apparatus, it is evident that the overall collection efficiency will be the efficiency of the preliminary separator times that of the cyclone precipitator.

If the dust from the cyclone is recirculated through the scroll or primary concentrator a second time, some of the dust which escaped the cyclone will be concentrated in the scroll and precipitated in the cyclone.

The following table shows the mathematical relationship of non-recirculation and recirculation. This is based upon the following formula:

$$E_t = \frac{E_c \times E_s}{1 - (1 - E_c)\, E_s}$$

E_t = total collection; E_c = cyclone efficiency; E_s = preliminary scroll or concentrator efficiency.

Scroll Efficiency	Cyclone Efficiency	Overall Collection Without Recirculation	Overall Collection With Recirculation
90	90	81	89
90	80	72	87.8
90	70	63	86.3
90	60	54	84.4
90	50	45	81.8

The above is given with a constant scroll efficiency of 90 per cent and a variable cyclone efficiency in order to show the mathematical proof of the importance of recirculation.

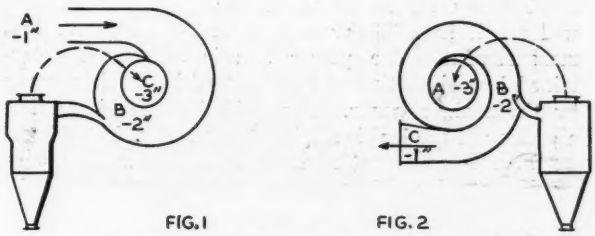


FIG. 1 FIG. 2

Fig. 1. No recirculation. Gas to outlet from cyclone
Fig. 2. Using recirculation. Gas to inlet from cyclone

It is certain that the dust which has gone to the cyclone has been capable of centrifugal separation in the scroll or it would never have reached the cyclone. Nevertheless, some of this dust may escape the cyclone a second time and in practice the percentages with recirculaton, which are so much higher than without recirculation, will be somewhat reduced, but it is quite evident that without recirculation the product of the two efficiencies is the best efficiency that can be hoped for, whereas with recirculation a higher efficiency is possible.

To recirculate the dust from the cyclone there must be a normal flow from a higher pressure area to a lower pressure area. Taking the two cases shown in the attached drawings, Fig. 1 shows the introduction of the dust at the larger end of the scroll, and Fig. 2 shows the introduction of the dust at the smaller end of the scroll. Since the center of the scroll must be considered the fan inlet, it is evident from the diagrams in the arrangement shown in Fig. 1 that, without an auxiliary fan, the gas cannot flow to a point of higher pressure which is the inlet of the scroll (the system shown in Fig. 1), but will normally flow (as in Fig. 2) to the point of lower pressure which is the beginning of the scroll preliminary concentrator system, and thus recirculation can be accomplished to the benefit of better collection.

RECTIFIER LOSS MEASUREMENTS

Novel Method of Measuring the losses in Mercury arc Rectifiers by the use of Copper Oxide Rectifiers in the Anode circuits in combination with wattmeter

By W. B. BATTEN

Westinghouse Electric & Manufacturing Co.

VALUABLE DATA REGARDING a rectifier's performance as well as its efficiency as a converter may be obtained from a measurement of the power loss of the rectifier under various conditions of load and temperature.

With a rectifier operating at normal voltage (say 600 v.) it is impossible to obtain an accurate loss measurement by taking the difference between the input and output. At this voltage the rectifier efficiency is in the neighborhood of 97 per cent. Thus a 1 per cent error in the input or output measurement will result in a 33 per cent error in the power loss measurement. The power loss is sometimes determined by calculating the amount of heat taken away by the cooling water. The objection to this is that a portion of the loss is dissipated as heat radiated from

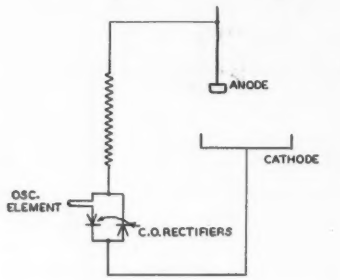


FIG. 1

Diagram of circuit for measuring arc drop with the oscillograph

the tank and anode radiators and this part is difficult to determine accurately.

The logical solution of the problem is the direct measurement of the losses by electrical means. A method of recording rectifier arc voltages with the oscillograph has been developed. This is accomplished by using the circuit shown in Fig. 1. The copper oxide rectifiers allow the current resulting from anode to cathode potential to flow through the oscillograph element as long as the anode is positive, but by-passes this current through the other copper oxide rectifier when the anode is negative. Fig. 2 shows such a record. The anode carries current whenever it is positive with respect to the cathode.

The actual loss in an anode of a rectifier is the product of its arc drop and current. If a current transformer is placed in the power circuit to the anode it saturates due to the unidirectional current. However, by placing a copper oxide rectifier in the secondary of the current transformer it is possible to measure the current in one anode. The copper oxide rectifier is so connected that the secondary current flows freely while the anode is carrying current. When the anode stops carrying current the current transformer is left with a certain amount of magnetic flux in its core. This flux tends to collapse and in so doing induces a voltage in the secondary which tends to set

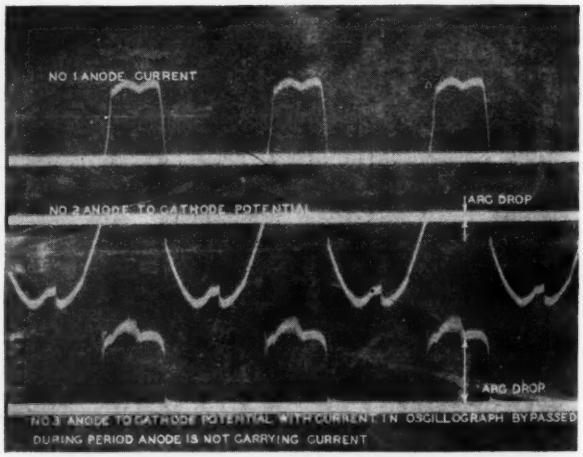

NO 1 ANODE CURRENT
NO 3 ANODE TO CATHODE POTENTIAL
ARC DROP
ARC DROP
NO 3 ANODE TO CATHODE POTENTIAL WITH CURRENT IN OSCILLOGRAPH BYPASSED DURING PERIOD ANODE IS NOT CARRYING CURRENT

Fig. 2. Sample oscillogram showing arc drop record

up a secondary current in the opposite direction from that produced when the anode is carrying current. The copper oxide rectifier prevents current flow in this direction. Therefore, the flux in the core of the current transformer collapses and in so doing induces a voltage across the copper oxide rectifier. No current tending to prevent the decay of the flux can flow and the transformer core becomes demagnetized during the portion of each cycle when no current is flowing in the anode. The result is that the secondary current is always a true measure of the anode current.

If we replace the oscillograph element shown in Fig. 1 by the moving coil of an indicating wattmeter, and if we connect the current transformer mentioned above (with the copper oxide rectifier in series) to the fixed coil of the wattmeter the deflection of the meter will be an accurate indication of the loss in that anode. This circuit is shown in Fig. 3. It is true that such a measurement gives the loss for one anode only and that several different current transformers must be used for different values of anode current. In the

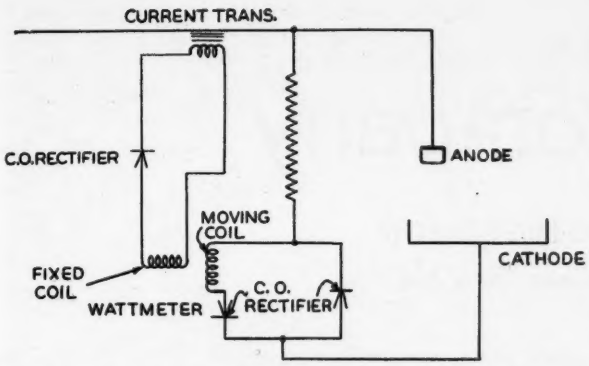


Fig. 3. Diagram of circuit for measuring loss in one anode of a rectifier by means of a wattmeter

laboratory it has been found that it is often possible to assume that all the anodes of a rectifier are balanced as to current and arc drop. When this is done the total rectifier loss is obtained by multiplying the loss in one by the number of anodes.

A variation of the above method by which it is possible to lessen the number of current transformers is as follows: Current from the anode current transformer is passed through the moving coil of a wattmeter or dynamometer. Current from the arc drop measuring device is passed through one fixed coil of

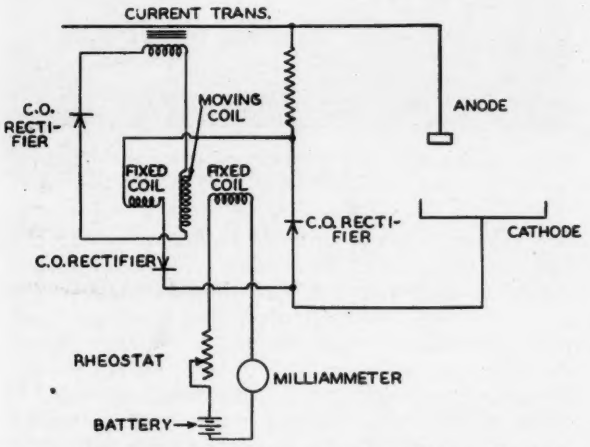


Fig. 4. Diagram of circuit for measuring equivalent arc drop of one anode of a rectifier using dynamometer and milliammeter

the dynamometer. Another fixed coil of the dynamometer is connected to a battery, milliammeter, and rheostat. The rheostat is adjusted until the dynamometer comes to zero, and the milliammeter reading recorded. The milliammeter can be calibrated to read arc drop. The number of necessary current transformer ratios is reduced because we are not restricted to the limits of the wattmeter scale. That is, the torque on the moving coil when acted on by one fixed coil may be sufficient to produce several times full scale deflection since the other fixed coil produces an equal and opposite torque when a reading is made. In this case the current must also be measured and the loss is obtained by multiplying the current by the arc drop. Figure 4 shows the circuit used for the above measurement.

Portable Trap Cuts Car Heating Time

Conspicuous among the "unsung heroes" of American industry are hundreds of plant engineers who have, in addition to routine responsibilities, developed original ideas and devices to effect further increases in their operating efficiencies. In most cases, these "brain children" are seldom brought to the attention of the trade; but it's this initiative and application that is saving many firms thousands of dollars each year.

When confronted with the inherent inefficiencies of

manually operated valves on a system for tank car heating, M. S. Rexford, Chief Engineer of the Gustafson Oil Company of Chicago, exercised a little ingenuity to effectively solve his problem. He rigged up a unique portable trap on a tripod frame with rubber hose connections as shown in the photograph.

Mr. Rexford reports that his "convenient" trap completely "fills the bill." The time required to heat a car has been cut from 5½ hours to 3½ hours—an impressive saving of 36%. The trap requires no attention, whereas several adjustments were required with the cracked valve before a car was heated. Now, the pressure on the boiler holds steady and a substantial saving in fuel has been effected.—Armstrong Trap Magazine.

"Since May the pollution of New York's air by smoke has gradually decreased. In September this pollution was .03 to .39 of a ton per cubic mile less than that of September last year. This was revealed by David R. Morris, of the New York Meteorological Observatory, who said the period ahead is one of normally increased fuel consumption, but that, despite this, smoke in the air will be determined largely by the kind of fuel used and how it is consumed, the direction of prevailing winds, etc.

Olson Rug Company

By EDMUND HIGGINSON
Mechanical Engineer, Olson Rug Co.

CONCEIVED AND BUILT during the depression as part of an unequalled industrial expansion program, the new power plant of the Olson Rug. Co., Chicago, Ill., is as unique as it is practical. Backed by the vigorous foresight that has made the Olson Rug Co. the largest of its kind in the world, Walter Olson in 1934 authorized the construction of a new factory unit, the third since 1929. In this new unit, Olson's engineers have designed the power plant, incorporating in it information and experience gleaned from an intensive study of power plants here and abroad. The result is a plant tailored to fit the specific needs of an industry exacting in its demands and costing but $150,000, $30,000 of which is allowed for building costs.

With a tolerant disregard for convention, Mr. Olson looked for and found new ways of accomplishing results. First the power plant is built as part of the main building. No one would suspect that a power plant reposed behind the windowed walls to the right of the shrubs in the photograph. If, however, they went close enough to see through the windows they would be surprised for the Olson Rug Co. is proud of the new plant. Tile walls, piping in trenches, floors covered with rugs, boilers painted in blazing red, conveyors in aluminum, operators in white uniforms, cut and potted flowers in wall niches are far from usual practice but are to be part of the ultimate plans.

Next, coal and ash bunkers have been eliminated and rectangular concrete towers, holding 12 and 2 carloads respectively, and running from ground to roof have been substituted. The rectangular section

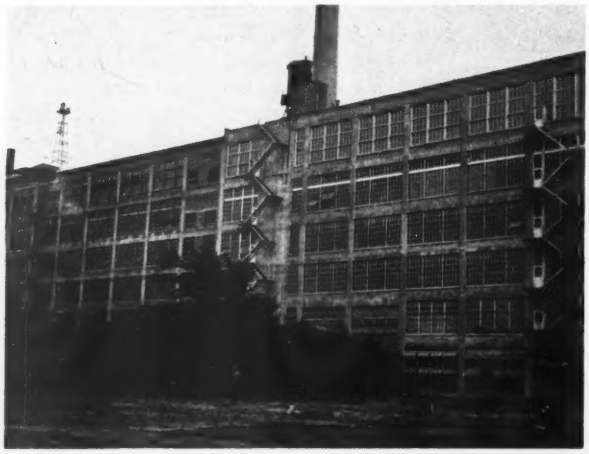


Fig. 1. Exterior view of the new building the power plant is in the central foreground just to the right of the shrubs

New power plant, built integral with factory building, has many innovations. Two 435 hp., 2775 lb., 250 deg. F. superheat boilers and noncondensing turbine generators with a total capacity of 1500 kv.a. Additional 1250 kv.a. generator and 750 hp. boiler under way

Fig. 2. Turbine room and switchboard looking through the glass partition from the boiler room

was selected after tests made to determine the cross section least subject to arching. The plant was designed to burn low cost screenings so the flow type conveyors were made with dustproof housings. Piping although necessary, does not add to the attractiveness of a plant so all steam and water lines are installed in covered trenches. A glass partition is provided between the boiler and turbine rooms so that the operators are in sight of each other at all times and visitors have an unobstructed view of both rooms from an observation balcony. The building was designed by Weiss & Neistadt, architects, of Chicago, from layouts planned by Olson and his engineers.

Formerly steam was supplied from four stoker fired boilers totaling 600 hp. and electric power was purchased. Most of the steam is used for washing, sterilizing, dyeing and drying wool and carpets. The load varies greatly with peaks ranging up to 35,000 lb. per hr. in the summer and 50,000 lb. per hr. in the winter. Electric power peaks range to 1000 kw. and from 100,000 to 250,000 kw-hr. is used per mo. Steam demand exceeds the electrical demand 80 per cent of the time.

After numerous detailed engineering studies Olson's engineers found 275 lb. pressure with 250 deg. F. superheat (about 650 deg. F. total steam temperature) to be the most economical. With this in mind the

plant was laid out to take care of present needs and allow expansion when necessary. The power plant measures 88 by 147 ft., divided by a glass partition into a turbine room 44 by 88 ft. and a boiler room 88 ft. square. The former is 20 ft. and the latter 35 ft. high.

Turbine Room

In the turbine room are two turbines with 220 v., 3 ph.; 60 cycle generators, and a 10 panel dead front switchboard complete with instruments and 3 voltage regulators. The two main generators are each 750 kv.a., the third unit rated at 1250 kv.a. (now on order) is intended for winter load. The turbines exhaust through automatic back pressure valves at from 0 to 25 lb. pressure depending upon load requirements. Exhaust steam is used for process and the excess beyond immediate needs is absorbed in three 10,000 gal. hot water tanks on the roof. Condensate from the closed heating coils in this tank is drained back to the feedwater heater and used in the boilers.

Boilers are of the four drum, bent tube type with a heating surface of 4350 sq. ft., set over a 1100 cu. ft. furnace and steel cased outside of 2 in. magnesia blocks. Bridgewalls are water cooled. Each boiler is fired by a double section sprinkling type stoker equipment with steam operated dump grates which discharge to a hopper 8 ft. below the grate line. Ash is handled from this hopper to the ash tower by a pneumatic ash conveyor.

Smoke

The electric eye is used to detect smoke and sounds an alarm when this takes place and indicates the density and length of the violation. CO_2 indicators are also installed on each boiler. Overfire draft gages are placed where the operator sees them without moving very far.

Back of each boiler is a forced draft fan driven by a 10-hp. induction motor and operating under control of a furnace pressure regulator. Fuel feed and the uptake damper are controlled by a steam pressure regulator. The concrete stack, 185 ft. high and 10 ft. dia. at the top extends from the foundation at the boiler room floor to 85 ft. above the roof of the building.

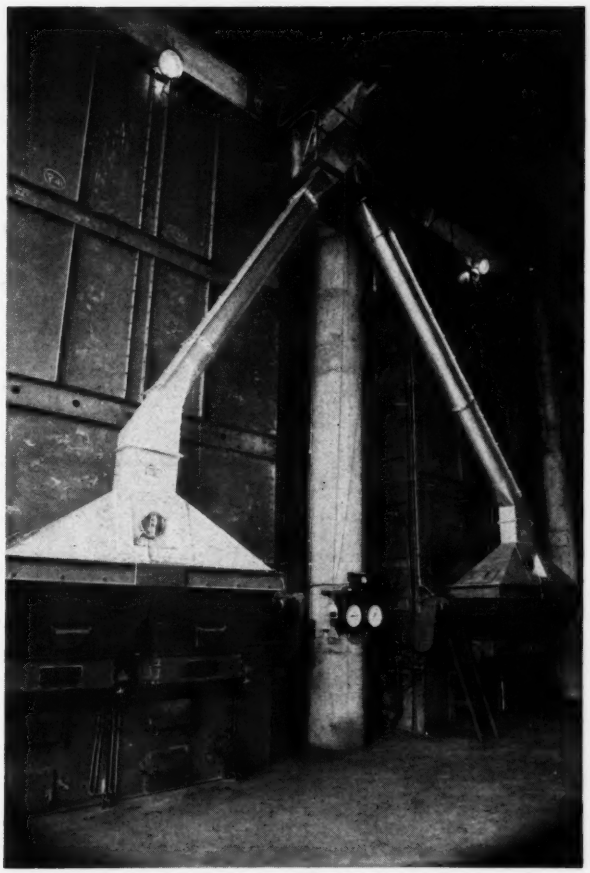


Fig. 3. Two 435 hp., 275 lb. boilers are installed with space for a third and fourth. An additional 750 hp. unit is planned for the immediate future

Coal is received by rail, dumped to a track hopper and elevated to the top of the coal tower by a flow type conveyor. From the bottom of the tower a simi-

(Continued on page 713)

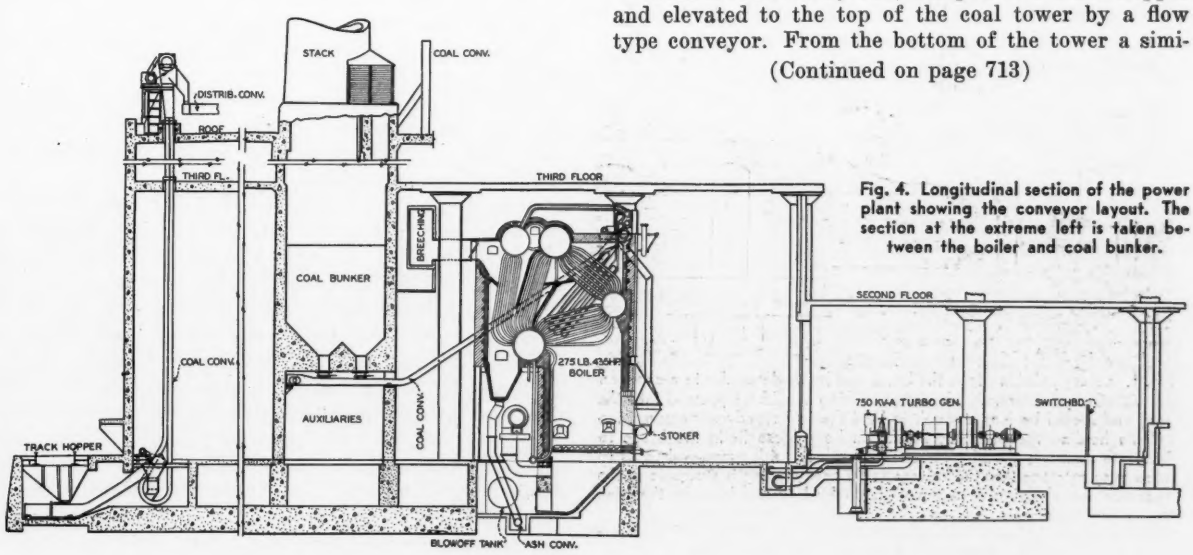


Fig. 4. Longitudinal section of the power plant showing the conveyor layout. The section at the extreme left is taken between the boiler and coal bunker.

Seals against Fluid Pressure

Part VII. Engineers in charge of work give ideas on maintenance of joints, using gaskets and packing.

SO FAR in this series of articles on Seals against Fluid Pressure the object has been to present information on joints which should be taken into consideration when deciding upon the type of joint to employ or selecting packing materials to be used. No discussion of this subject would be complete without presenting the views of men directly in charge of maintenance work of this sort in power plants. After all, the principal object of a joint is to prevent leaks in places where openings must be made occasionally and the man who has to live with these joints usually learns their failings.

To vary the treatment as presented in past issues, two engineers with broad experience have been prevailed upon to contribute information and opinions on this subject which should be of assistance to others in solving their gasket and packing problems. Julius Brodsky, a boiler room engineer, gives information on sealing handhole and manhole openings in boilers, and following his comments is a short discourse on the solution of all packing problems by Mark Bell, an engineer with experience in power plants of the British navy, but more recently in United States industrial plants.

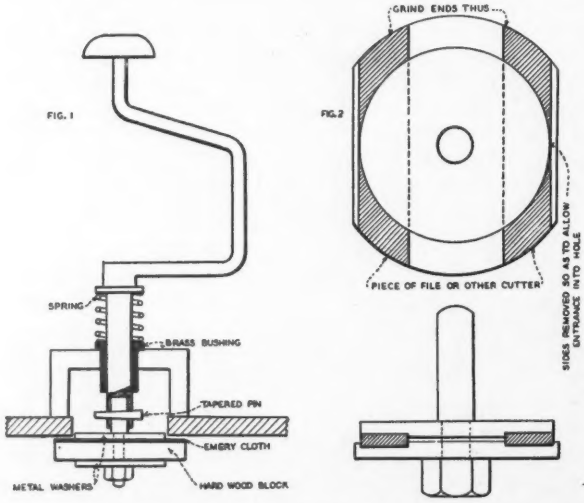


Fig. 1. Rotary polishing tool, the brace can be made similar to a common automobile speed-wrench; the brass bushing should be pressed into the yoke and should be long enough to hold the tool steady while using, the spindle holding the polishing block can be a loose fit in the brace to facilitate removal; the block is circular with the sides removed so as to allow easy entrance into the holes, a fairly heavy spring is desirable as the operator can always relieve the pressure by bearing down on the tool. Fig. 2. Rotary scraper made from pieces of old file, tapered sections of file should not be used, only pieces having same width and thickness should be used, ends should be ground as shown.

Consider the Boiler Gaskets

By Julius Brodsky

SEALING MANHOLE and handhole openings, so that there will be no leakage or possibility of gaskets being blown out, should include not only the selection and use of a suitable type of gasket, but the thorough cleaning and resurfacing if necessary of the bearing surfaces, and the placing in position and tightening up of the plates so that the gasket will neither be moved out of position or damaged.

In most cases the selection of the type of gasket used is determined by the operators personal experience. The type of gasket selected for any particular installation, however, should be the one that gives the best service at the lowest cost; this can best be determined by placing several of each type offered in service and noting the results obtained.

Any reputable manufacturer will recommend a suitable type and most are willing to furnish samples so that a test under actual service conditions may be made to determine their merits.

Very complete descriptions of the manufacture and application of various packings and gaskets have been published in previous issues of Power Plant Engineering and this information should be used as a guide in selection of the gasket to be used.

The molded lead gasket still has many adherents. The cost is low, since all the old gaskets are remelted with the addition of any lead scrap that may be available; the maintenance man utilizing his spare time for this work. They are particularly suited for uneven surfaces, since the lead flows easily as pressure is applied and the metal fills all cavities and uneven spaces; due to the low melting point of lead, however, they are limited to the lower pressures.

Many plants in which this type of gasket was formerly used have seen fit to change to some of the later types now on the market.

The folded asbestos gasket is probably more familiar than any other type. It is made of asbestos cloth, which is treated with a heat resisting compound and then folded and pressed to the required shape and size. This type is in general use for manhole openings; many are used to seal handhole openings, but since they are usually made four-ply or four thicknesses of cloth folded over, the gaskets are at least ⅛ in. thick and many operators prefer a thinner gasket and one of greater strength.

Factory cutting from sheets of compressed asbestos allows the use of a thinner gasket and one having greater strength, the usual thickness is 1/16 in.; when using this type the bearing surfaces should be maintained in first class condition.

Metal clad gaskets present a type suitable for many installations. There are various types and grades on the market and the most suitable one should be determined only from the results obtained in service. While the unit cost of this type may be higher, in general better service may be expected, making it in most cases the most economical in the long run.

A tight joint cannot be secured without clean bearing surfaces. It is imperative that all fragments of old gaskets, scale and other foreign matter be removed. Any cavities that may exist should be filled or the surface trued up so as to eliminate them.

When no water conditioning program is in effect, scale will build up in the headers and accumulate around the plate while the boiler is in service, and this must be removed so as to allow sufficient clearance around the edges of the plate so that it can be moved into the correct position.

The work of cleaning is usually done with homemade scrapers made from old files, hack saw blades or other available material and shaped to conform to the boiler cleaner's individual preference.

Where conditions permit, much time and labor can be saved by cleaning the interior header surfaces with a rotary tool. One such is shown in Fig. 1; this consists of a brace to which is attached a short removable spindle to the end of which is attached a hard wood block with a sheet of rough emery cloth clamped to it; the spring on the brace holds the emery cloth against the header surface while the operator rotates the tool. When through cleaning one hole the operator bears down on the brace, compressing the spring, allowing the tapered pin to be removed and the polishing block to be taken out and set up in the next hole. If there is no great accumulation of scale or foreign matter the surface can be kept in first class shape; when it is found that the emery cloth is ineffective it becomes necessary to use a metal tool such as shown in Fig. 2.

This can be made from a couple of pieces of an old flat file, ground to the right shape and clamped between two metal washers.

Where machine shop facilities are available, cutting tools such as are used for truing up valve seats may be made up and used in lieu of the pieces of file.

Where cavities exist in the header surface, they should be filled by first thoroughly cleaning and then making a paste of iron cement and applying it according to the manufacturer's directions.

In some of the older types of boilers where the headers are made from cast steel by the open hearth process, large blow holes have been found, making it necessary to fill them by arc welding and finishing with a portable grinder; since the headers in modern boilers are made from electric steel, this defect is no longer found.

Sometimes over a long period of time the cleaning has been so neglected and so much corrosion has taken place that it is no longer possible to maintain a good bearing surface and eliminate leaks and it becomes necessary to resort to resurfacing the headers. A simple tool for this purpose is shown in Fig. 3, with the means provided for feeding the tool and holding it in the required position. The cutting tool to be used should have a serrated or nicked tooth cutting face, so as to break up the chips and reduce the amount of power required to rotate the tool.

Cleaning of manhole surfaces presents no great difficulty, as it is always possible to enter a boiler and use regular tools for this work.

Handhole and manhole plates can be removed to the work bench and kept in good shape by the proper use of files and scrapers. Sometimes due to corrosion, the bearing surface is inadequate to make a tight joint and it is necessary to discard the plate and replace it with a new one; when only one or two handhole plates are defective, the purchase of new plates is probably the cheapest procedure; when it becomes necessary to replace very many, however, serious consideration should be given to some method of refacing them. If the plates are round, chucking them in a lathe and taking a light cut is the best method, it is desirable to give them a "phonograph" finish such as is found on pipe flanges.

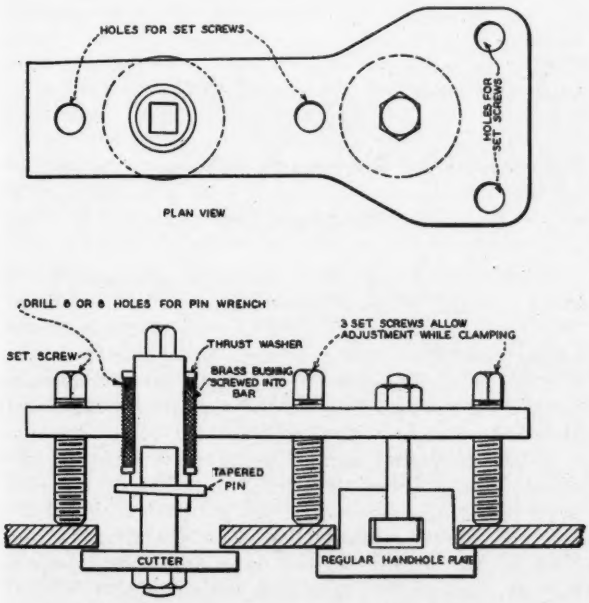


Fig. 3. Tool for refacing, a 1 by 4 in. bar is clamped in position, 3 set screws are used instead of yoke and allow of necessary adjustment, additional set screw is provided on cutter end to steady tool; bar is drilled and tapped and bushing screwed into it, feeding is accomplished by screwing up on bushing; with tool rotated clockwise and right hand thread on bushing there will be a tendency for tool to move away from work instead of digging in as is the case when drilling with a ratchet drill and "old man," bushing is drilled so as to be turned by means of pin or spanner wrench; arbor holding cutter should be a good fit in spindle.

If the plates happen to be oval, square, pear shaped or any other irregular shape, some other means must be found for doing this work. In Fig. 4 is shown a simple fixture that will meet the requirements. The plate is clamped on a holding device which rests on a number of steel balls and is free to be moved in any direction. A grinding wheel with provision for adjustment in a vertical direction is clamped in a fixed position. The surface of the plate is then brought under the wheel and the operator keeps moving the plate until the whole surface has been ground. Good results have been obtained when a tool post grinder has been clamped in the tool post of a shaper and the holding fixture set on the shaper table.

Particular care should be exercised in placing the plates in position. The gaskets should fit snugly on the plate so as to prevent any movement while tightening up or getting the plate in a central position. To make the gaskets easily removable, graphite is applied to the gasket surfaces. Gaskets made from compressed sheet

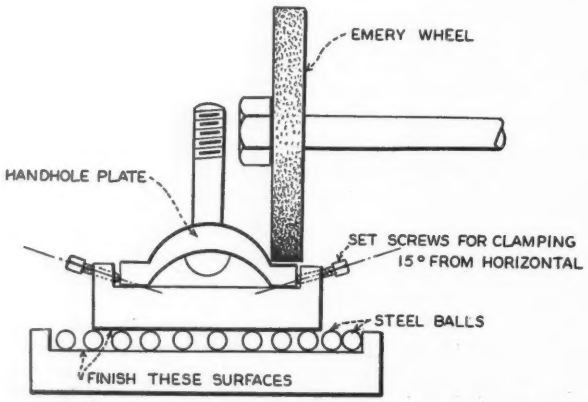


Fig. 4. Fixture for truing up plates, top member in which plate is clamped and bottom member in which balls rest should be made from cast iron, bottom member is circular in shape to facilitate machining, finished surfaces are indicated, set screws in upper member should incline 15 deg. from horizontal so as to hold plate firmly. Emery wheel should be dressed frequently to obtain level surface. Milling cutter, preferably an end mill, could be used instead of emery wheel.

asbestos can be obtained with a graphite finish and this is preferable if this type of gasket is used.

It has long been a custom to paint the gasket surfaces with a mixture of flake graphite and cylinder oil; this is objectionable, since the surplus oil will be squeezed out and eventually deposited on the heating surfaces of the boiler. A far better method is to soak the gaskets for a short time in a bucket of water and then dust powdered graphite over them.

The usual method of setting the plates is by using a couple of screwdrivers to move the plate so that it will set centrally in the hole while tightening up.

Sometimes trouble is experienced with manhole plates in keeping the gasket in the right place while getting the plate into position, when graphite has been applied to both sides of the gasket. When this trouble is experienced, the best method is to remove all traces of graphite from the surface of the plate and apply a good coating of orange shellac, then place the gasket on the plate and weight it down, leaving it overnight if time allows; the gasket will not slide around while getting the plate in position and will be easily removable at the next boiler cleaning; graphite is applied as usual between the gasket and the surface of the manhole.

Before replacing plates, all studs on handhole plates and the holding bolts on manhole plates should be run over with a standard die, and the nuts tried on them to see that they can easily be turned by hand. This is necessary, as the maintenance man will then know that all of the pressure that he is applying by means of a wrench is used in compressing the gasket and not in galling the threads.

It is advisable to go over the plates several times when tightening them up, taking up a little each time, and the final tightening should be done when the boiler is hot but before it begins to steam. Particular attention should be paid to the yokes on manhole plates to see that they do not move out of position; no attempt should be made to straighten them up if the boiler is hot and while full of water, then boiler should be cooled down and the water drawn down below the bottom of the plate before resetting in position.

Testing the boiler with cold water pressure to see if any leaks exist is advisable, however many times a plate that will leak when cold even under pressure will take up and stop leaking when the boiler is hot.

Should a leak develop at a handhole or manhole opening while the boiler is under pressure, under no circumstances should any attempt be made to stop it by tightening the bolts, as the consequences might be disastrous. The only remedy is to remove the pressure and cool the boiler down and replace the defective gasket; while this might take a little time it is better to be safe than sorry.

With the right care and attention given to keeping the header and plate surfaces in good condition and the use of suitable gaskets which are not damaged while applying them, no trouble should ever be experienced from leakage around the plates or from gaskets being blown out.

Solution of All Packing Problems

By Mark Bell

THERE ARE innumerable brands of packing on the market, many of them possessing excellent qualities. There will always be found many advocates for each but it requires a very wide experience to enable a person to be really authoritative on this controversial subject. Amongst engineers there is always argument about the correct width for gaskets. Some advocate a full faced gasket, some a smaller diameter. If the flange faces are absolutely true the full faced type has great advantage, especially if a tight shut off is obtainable and there is steam leakage which prevents getting close up to the job. In that case a bolt may be put through one hole of the gasket, the whole then slipped round with a hammer shaft and the rest of the bolts put in and tightened up.

The big disadvantage with a small diameter gasket is that it tends to distort the flange faces and, probably, store up trouble the next time the job is done. In the British Navy, where gunfire causes great vibration, male and female flanges are used with very thin jointing between.

Is there a universal panacea for all packing troubles? Suppose one were ordered to the most inaccessible spot in Thibet to overhaul an engine and transportation difficulties made it obligatory to reduce supplies to a minimum. Suppose further that the joints to be made included hot liquid, gas, steam and water. Would it be possible to carry only one type of jointing for all of them? I submit, very emphatically, that it would and, in support of this opinion, offer a very wide experience on varied work in many countries.

Suppose there would be many different kinds of glands to pack; would it be possible to take along one brand and one size of packing to do a good job on all of them? Again I submit that it would be possible.

Here is what I would take along:—

Several packets of a joint paste made principally of manganese.

A sheet of fine gauze wire (obligatory).

A can of shredded metallic gland packing.

With these few articles I would guarantee to do a good job on any work that any other packing would not improve on. What a saving in cost, bulk and weight. With these two packings I have worked for many years and have never had a failure. With this joint paste, temperature or pressure, liquid or vapor, it is all one. Properly installed, the joint will outlast the metal itself and none can demand more.

The operation is simple. With a pair of scissors cut out the gauze wire to fit the flange getting all holes in line. With this paste it is not absolutely necessary to scrape off the flange faces so exactly as with a sheet packing and this is a very desirable feature when there is some steam or other leakage. Break off a small piece of paste and knead it between the hands to a putty consistency. Roll it out like a cigarette and place a ring around the center hole of the gauze. Do the same at the other side of the gauze. With the thumb and finger squeeze it out slightly so that it penetrates and holds in place. Slip it in place and tighten up the bolts evenly all around. It is not even necessary to put too great a strain on the bolts, a good, even tightening up is all that is required. Open up the line slowly and you have a flange joint that will remain tight under all conditions until that old horn blows or the whole line gives out through old age.

When using this method do not expect to break the joint easily for future repair. A hammer and chisel would be needed as it sets far harder than cement. When making a joint that is likely to be opened occasionally spread the flange faces with graphite grease before making the joint with the paste and this will enable it to be broken without impairing the job. Even the gauze may be dispensed with. Its sole purpose is to hold the paste in place until tightened up. I have used thin cotton instead. In vertical work it is quite possible to place the paste directly around the hole, on the flange metal and then bolt the other member in place.

Now as regards the shredded metallic gland packing, large or small, deep or shallow, wide or narrow, whatever gland it may happen to be, this packing will fill it. There is no waste, no cutting, no small ends left over, no carrying in stock of varied sizes and no frequent after tightening. Once in and correctly tightened up, the only attention it may need is some slight refilling, and that only after a considerable time.

Engineers' Council for Professional Development

ENGINEERS' COUNCIL for Professional Development, participated in by the national societies of chemical, civil, electrical, mechanical and mining engineering, by the Society for Promotion of Engineering Education and National Council of State Boards of Engineering Examiners, at its meeting on Oct. 6 reëlected Charles F. Scott of Yale University as chairman, H. H. Henline as secretary, R. I. Rees as vice-chairman and C. E. Davies as assistant secretary. List of accredited courses of study in New England and Middle Atlantic states was adopted but not made public. Efforts to find a basis for estimating probable success of a student before he enters on an engineering course were discussed, also plans for study courses for junior engineers. Heads of committees are: Student Selection and Guidance, Dean R. L. Sackett of Penn. State College; Engineering Schools, President K. T. Compton of Mass. Inst. of Technology; Professional Training, R. I. Rees; Professional Recognition, C. N. Lauer; Ways and Means, R. I. Rees; Information, H. C. Parmelee.

Olson Rug Co.

(Continued from p. 709)

lar conveyor picks up the coal and delivers it to the stoker hoppers as shown by the photographs and drawings. The hoppers are fitted with dustproof hoods and the coal level is controlled by a level indicator visible in the photograph.

Boiler feedwater is heated in a 42,000 lb. per hr. deaerating heater supplied with exhaust steam from the feed pumps and turbine. Treated city water is used for makeup. The two boiler feed pumps are both of the direct acting type, one 6 by 8 by 6 in. horizontal duplex, the other a 8 by 12 in. simplex. Boiler water level is controlled by feedwater regulators and boiler concentration by a continuous blowdown.

The average load is at present 800 kw. The utility company maintains a standby service.

PROPOSED REFRIGERATION

Olson engineers are planning to install steam jet refrigeration to use up excess steam during the summer and to cool water for drinking purposes and ventilate and cool their vast sales and carpet displays rooms.

It is planned to drill a deep well and use this water for circulation in the steam jet refrigeration. In addition to the new turbine now on order, this company is contemplating the purchase of a 750 b.hp. steam generating unit in the near future. The carpet plant is one of the most modern and up to date in the United States, all built of reenforced concrete throughout. Cinder catchers and air washers are being installed to prevent air pollution and to keep the neighborhood clean.

Industrial Boiler Operation

Soy bean processing plant installed preheated overfire air injection with good results. By A. J. Einikey, Chief Engineer, Archer-Daniels-Midland Co.

AS ONE OF the most versatile vegetables known, the soy bean is becoming increasingly important in this country. Oil for food and industrial uses, paint, stock feed, flour and even automobile parts are being made from it. With one process the bean is first flaked by rolling, the oil extracted by naptha, leaving the solid part of the bean. The naptha is then distilled, to recover the oil.

Considerable quantities of steam are used and in the Archer-Daniels-Midland Co. plant in Chicago, Ill., this is supplied by a new boiler plant with two 150 lb. h.r.t. boilers, fired by single retort underfeed stokers, and equipped with Elesco bent tube type superheaters. One boiler is rated at 157 and the other at 237 b.hp. The boilers can without difficulty be operated at 200 per cent rating, leaving one unit to carry the load while the other serves as standby. Steam to all departments is metered by Republic flow meters and the boiler damper and stoker operation is under the control of a Republic regulator. At present Illinois screening running about 12,500 B.t.u. per lb. is being burned. This coal, received by rail, is dumped to a track hopper and elevated to an outside bunker built above the boiler room by a 9 in. Redler conveyor.

Although the boilers are set 30 in. above the grates and carry their load easily without smoke considerable quantities of refuse are sometimes burned and a new type of overfire steam jet, using preheated air has been installed and found effective in preventing smoke under the most severe conditions.

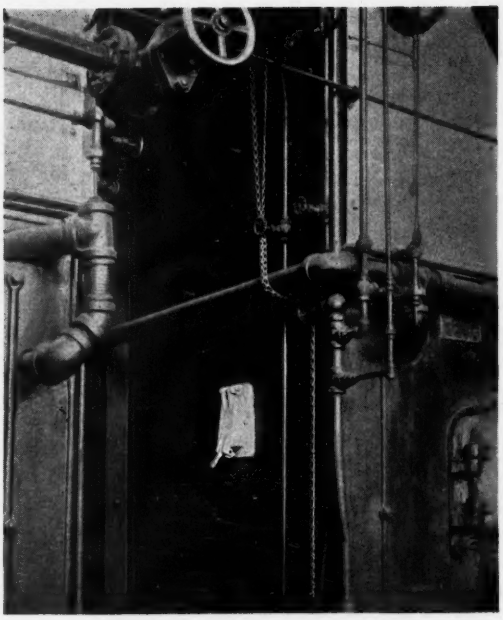


Fig. 1. Arrangement of heating pipes in the bridge and side walls

This steam jet system shown by the illustration is easily made and installed on any boiler by removing two courses of brick from the bridge wall and installing a 3 or 4 in. iron pipe extending across the furnace. As installed on the above boilers, a hairpin bend with 4 in. pipe was used. One end of this pipe is taken to the front of the boiler and enters the furnace diagonally about 10 in. above the grates. Draft is supplied by a quarter inch steam jet in the elbow as shown by Fig. 1.

The boiler on the right was installed first and the heating pipe added after the setting was completed. The pipe from the bridgewall to the front of the boiler was therefore run outside the setting as shown simply as a matter of convenience. The boiler on the left installed later has this pipe incorporated in the side wall and makes a neater job.

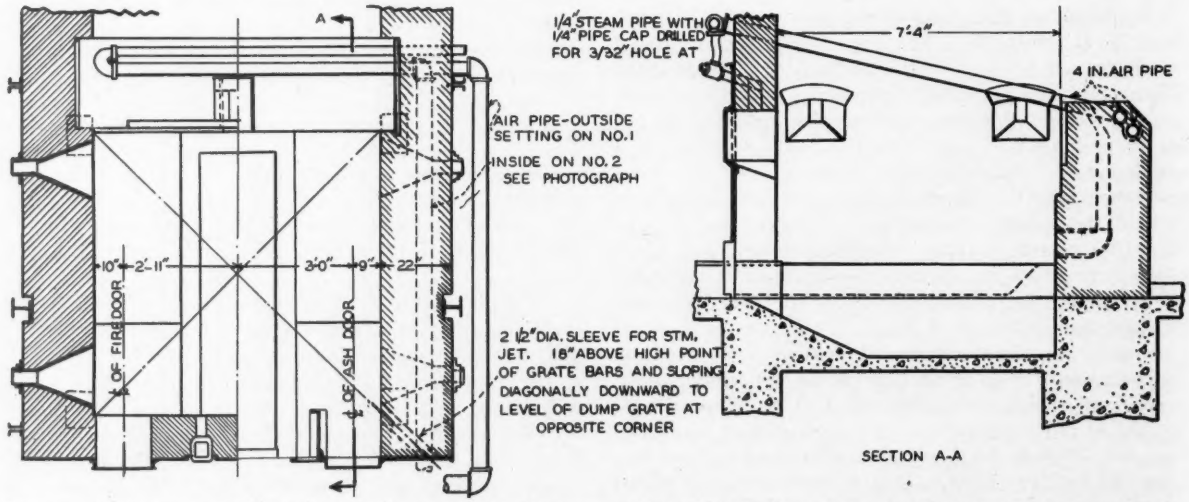

A
AIR PIPE-OUTSIDE SETTING ON NO.1
INSIDE ON NO.2 SEE PHOTOGRAPH
10"
2'-11"
3'-0"
9"
22"
OF FIRE DOOR
OF ASH DOOR
1/4" STEAM PIPE WITH 1/4" PIPE CAP DRILLED FOR 3/32" HOLE AT
7'-4"
4 IN. AIR PIPE
2 1/2" DIA. SLEEVE FOR STM. JET. 18" ABOVE HIGH POINT OF GRATE BARS AND SLOPING DIAGONALLY DOWNWARD TO LEVEL OF DUMP GRATE AT OPPOSITE CORNER
SECTION A-A

Fig. 2. The air pipes and steam jet nozzles. On the right the pipes were installed outside; in the boiler on the left they were incorporated in the side walls while the setting was constructed

The Thermit Reaction—Repair of main drive shaft in street railway cable drive power plant.

Reclaiming Broken Parts by THERMIT WELDING

BROKEN CRANKSHAFTS, crossheads and connecting rods, fractured and worn generator shafts, damaged flywheels, cracked cylinders, heads and engine beds need not always be scrapped. Nine times out of ten such parts can be repaired economically by Thermit Welding.

Repairs made in this way are not only permanent, but also frequently result in parts becoming more dependable than when new. This is because the failure of the original part may have been caused by an invisible flaw which was not discovered until the failure occurred. With the flaw eliminated by welding, however, and the remainder of the part thoroughly tested in service, the welded piece can be regarded both as perfectly sound and as having the full factor of safety for which it was originally designed.

Differing from other welding methods in that it requires no outside source of heat or energy. Thermit welding is a chemical process based on the high affinity of aluminum for oxygen. Thermit is simply a mixture of iron oxide and finely divided aluminum, which, up to a temperature of 2800 deg. F., is inert. When the mixture is ignited, however, a rapid reaction takes place and the aluminum unites with the oxygen in the iron oxide to form a light alumina slag while the iron is set free as a highly superheated steel at a temperature of nearly 5000 deg. F. If the reaction occurs in a refractory-lined crucible, the molten steel drops to the bottom where it easily can be drawn off for use as weld metal, while the slag separates and floats to the top.

The process is primarily suited to the joining of heavy sections of ferrous metals and in steel mills it has become common practice to Thermit weld broken solid steel rolls as great as 40 or 50 in. in diameter. Theoretically, in fact, there is no limit to the thickness of the section that can be welded successfully with Thermit, as the weld metal is deposited all at one time and there is only one shrinkage in the entire weld. On the other hand, with welding processes in which the metal is deposited layer upon layer, usually in a deep groove, each of these layers cools and contracts almost as soon as deposited and tends to interfere with the normal contraction of the succeeding layer. The internal stresses resulting from layer welding are not serious where the sections are thin enough to warp or stretch, but, in heavy sections, just where it is not always practical to do so, stress relieving of welded parts is almost essential to satisfactory results.

In general, welding with Thermit is an exceedingly simple procedure, requiring little training or manual dexterity. When making a Thermit weld, the parts are merely lined up, surrounded with a wax pattern and a mold box rammed with foundry sand to form a mold of the desired shape, and preheated to a prescribed temperature. The liquid steel, obtained from the Thermit reaction is then poured into the mold where it melts the ends of the parts to be welded and fuses with them to form a homogeneous mass and provide

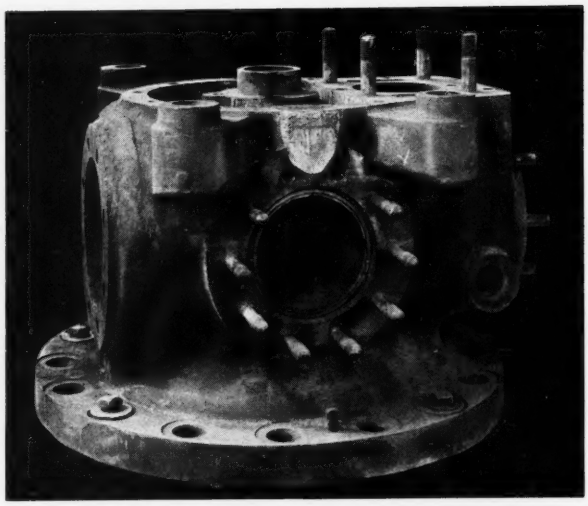
a weld as strong, if not stronger than the original piece.

When making a crankshaft weld, the parts of the broken shaft are lined up and supported in position by "V" blocks mounted on a machined bed plate. The longer end of the shaft is clamped rigidly in place while the shorter end, left free to move, is offset in such a way that the cooling and contraction of the weld draws it back into approximate alignment. After welding, a light cut is usually necessary on the short end to bring the entire shaft into perfect alignment. The amount of machining required, however, is never very great. For example, the repair of a double break in the web of a 15 ft. long, 8½ in. diameter, single throw shaft in the power plant of a New York electric company resulted in only 1/16 in. distortion.

Where it is not feasible to reline the shaft bearing to compensate for even a slight reduction in the diameter of the shaft, the original short end may simply be discarded and a new end of slightly larger diameter welded on in its place. The new section may then be turned down to the exact size of the original shaft. This same general procedure also may be followed with badly worn generator and other shafts, the worn ends being cut off and new ends welded on. In addition, the altering of shafts which show signs of faulty design is entirely practical. One such case, for instance, involved the shaft of a vertical hydro-electric generator unit in a Maine power plant. This shaft supported the rotor of the unit and had a thrust bearing at the top. Failure occurred in the threaded portion which engaged the nut for holding the upper member of the thrust bearing to the shaft and was caused by the fact that the thrust bearing was too light to prevent play and oscillation. Discarding the old shaft end and welding on a billet of larger diameter in its place made it possible to correct the difficulty by substituting a larger and heavier thrust bearing.

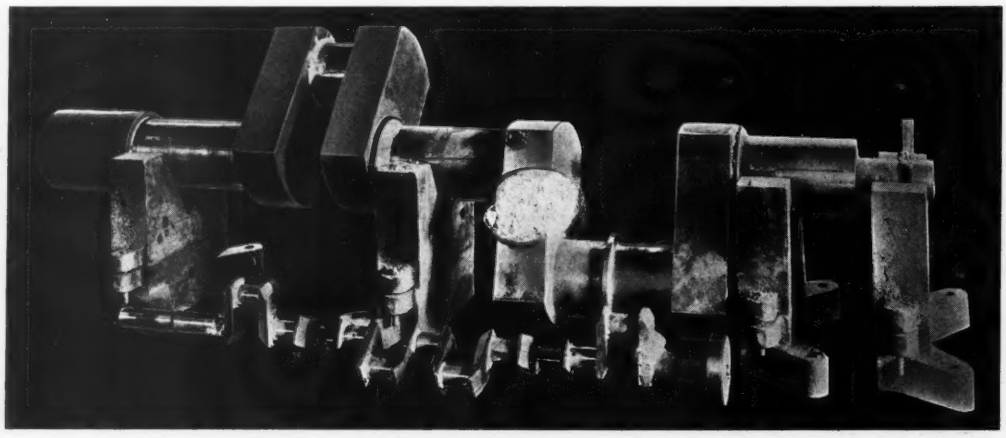
Hundreds of shafts of every description, many of them with main journal breaks, have been successfully repaired by these methods and have given years of satisfactory service thereafter.

The cost of making a Thermit repair ordinarily ranges between 20 and 50 per cent of the cost of obtaining and installing a new part. Materials and equipment employed in welding are far less expensive than a whole new casting or forging, and, the larger and more intricate the part the greater this difference becomes. Furthermore, since the entire machine generally must be dismantled, either to weld the broken part or to install a new one, the only additional labor involved is the actual labor used in welding.



Cylinder casting restored to service by welding

The fact that these repairs can be made in a day or two, as compared with the weeks generally required in which to obtain new parts, is also an important factor in that it eliminates prolonged and costly shut-downs of essential equipment. One interesting recent example of a speedy repair which saved a steel railway from a serious shut-down occurred in San Francisco when the main drive shaft of a cable drive power plant failed at mid-afternoon on a Saturday. To obtain and install a new shaft would have taken weeks and would have meant a complete cessation of street car service during that time. Instead, the shaft, which was 18½ ft. long and 13½ in. in diameter, was welded in position over the week end and the plant was back in operation by three o'clock Monday morning. Aside from the speed with which the repair was made, results were somewhat remarkable in that, after welding the shaft was no more than 1/32 in. out of line; less, in fact, than it had been before it failed.



Web Fractures in crankshaft repaired by Thermit Welding

Maintenance Jobs in Factory Plant

Maintenance Jobs in Factory Plant Turning Down Commutators under difficulties; flexible coupling to replace belt.

By Fred S. Rutledge

SKETCHES, Fig. 1, are to illustrate side and top views of a 75-hp. d.c. motor installed in a grain elevator, the commutator of which had become badly burned and worn through use and lack of attention. After it was installed, quite a lot of altering and addition of elevating legs or boots had been done without any thought of the possible need of repair work on the motor commutator. Consequently, it would have been quite an expensive job to have taken the motor out. A friend of mine, who was a machinist out of a job temporarily, heard about it and he and I took the job of turning the commutator up, on the job, without shutting the plant down for any of the running time which was from 6:00 a.m. to 6:00 p.m., 6 days per week and sometimes on Sunday also.

We got word that we could start on Saturday evening as soon as they shut down, that they would have to run Sunday afternoon, and if the job was not ready to run we got no pay. We had taken measurements and made three clamps to fit on the frame as shown in sketch No. 2 to hold a flat plate X having a hole Y for bolting the cross feed of a small lathe, parallel with the shaft of the machine. Sketch No. 3 shows the clamps as made except that the center one was made longer than the others. As shown in No. 1, there were only three arms holding the bearing frame and the B arm, sketch No. 1, was enough below the center line so that it fit in with our plans nicely. The bearing and bearing housing were split through C and by removing them we got a place to line up the cross feed with the shaft, which was in good condition. The pulley was on the opposite end of the shaft. Not being able to get any motor with which to turn the commutator while doing the job, we made a crank of 2 by 4 in. wood, sketch No. 4, with a 1-in. pipe P for a handle. We started work at 6:15 p.m. Saturday, removed all brush rigging and belt, put on rig for holding cross feed, clamped crank on shaft and "went to it." We were done and all brush rigging and parts replaced and motor tried out, job accepted and pay in our pockets at 1:40 a.m. Sunday. We got $15.00 for doing it, which was a lot of money in those days and personally I would not do it again for the whole amount, but we surely did some sweating. It would have cost more than we got to have removed the commutator and replace it plus the cartage, machining and time lost, so everybody was satisfied.

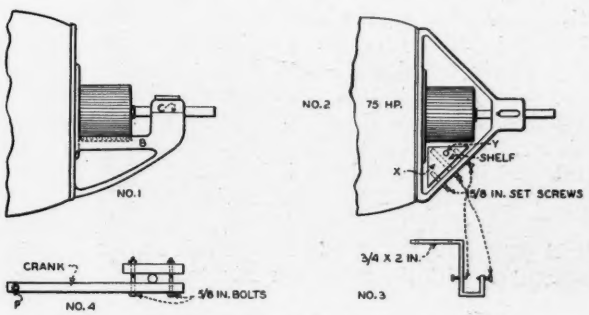


Fig. 1. Improvised means for turning down commutator

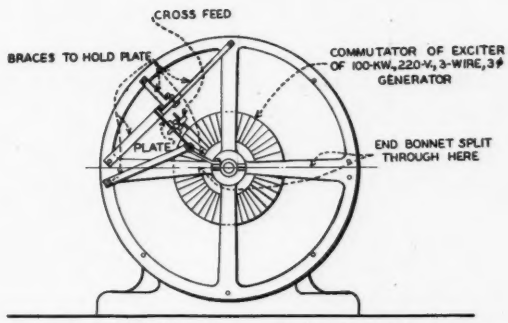

CROSS FEED
BRACES TO HOLD PLATE
COMMUTATOR OF EXCITER OF 100-KW., 220-V., 3-WIRE, 3φ GENERATOR
PLATE
END BONNET SPLIT THROUGH HERE

Fig. 2. Tool holding braces attached to exciter frame

Turning Down Exciter Commutator

Figure 2 illustrates a similar job done on the exciter commutator of a 100-kw., 3-wire, 3-phase a.c. machine, the commutator mounted on the same shaft as the field of the a.c. machine, it being a rotating field. A plate and braces were fastened to the frame but, on account of the arrangement of the bonnet arms, required a different layout than the previous job. There was no room to use a cross feed available from any lathe so the cross feed from a small hand power lathe used for turning up brass valve seats was used.

This machine was operated 24 hr. per day, 6 days per week and occasionally 6 to 8 hr. on Sundays, as there were no arrangements for emergency lights except in the engine room and boiler house. There were grooves ¼ in. deep worn in this commutator which

had been in service about 30 yr. without having any attention paid to it except to wipe off the commutator and collector rings occasionally with a clean cotton cloth. It got so bad that even with a voltage regulator it would not hold the voltage within 25 v. of that required, 220, running that amount under and over, 195 to 245, which played hob with lights, to say nothing about the machine itself.

All braces were made in readiness for the job and a small engine set up to drive it while doing the job. Only by changing brushes while the machine was running, was it possible to operate the last three days. That meant 72 hr. but 12 brushes were worn out in 8 hr., and when they shut down on Sunday at 6:00 a.m., the contacts between brushes and commutator were so bad that the machine would not generate any

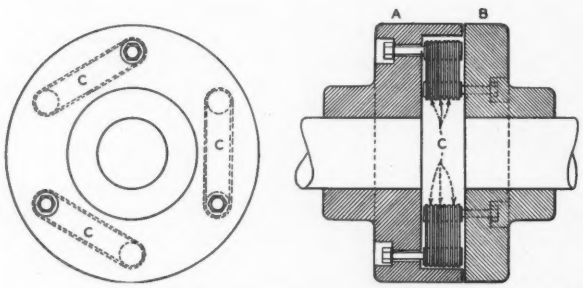


Fig. 3. Flange coupling made flexible by means of leather links

more. Three days would have been required to take the machine down, cart the commutator to and from the shop, turn it down and reassemble. We set up our rig and turned it down and had it ready for and in operation by 6:00 p.m. the same day, and would have had it ready sooner but we could take only a very light cut on account of the cross feed. Neither of these commutators had the mica under-cut and that helped out quite a lot.

Reversed Polarity

Among other things connected to the lighting circuit in an industrial power plant were some magnetic belt shifters on two wire weaving machines. They were constructed in such a manner that if the wire jumped out of the feeder guide, from any cause, a circuit was set up through the frame of the machine, energizing the belt shifter magnets and throwing the driving belt onto a loose pulley and the machine stopped. These magnets had to be connected so that the polarity was right or the belt shifter magnets would fail to operate. Occasionally the motor belt driving the generator furnishing the shifter magnets with current would break and the generator stop. When this happened the generator would reverse polarity and when started up the belt shifters on wire machines failed to operate when needed and before the operator could shut off the motor driving them, wire was shot all over the room and there were two narrow escapes from serious injury resulting from this condition.

The first time this happened after I took charge I reversed the generator leads, which was easy to do, but I didn't wait for it to happen the second time. I had the millwright make a frame of 8 by 12 in. timbers, mounted the motor and generator on it end to end and coupled them together with a flexible coupling made from an old flange coupling picked up in the scrap heap. It was made for a 3-in. shaft and by bushing the holes and reboning to the sizes required there was plenty of stock left to make the coupling as shown in Fig. 3. One half was recessed, three pins set in each half and seven strips of leather used for coupling elements between each set of pins, one pin in A half and one pin in B half, making a set, 21 strips required. The cost to the company was just about nothing for the whole job, as it was done in such a way that no special time was charged up to the job, except the millwright's time for making the frame. The coupling was absolutely fool-proof as to direction of rotation and after being used 4 yr. was transferred to another job where it is still in operation. Shortly before this change was made, the 250 r.p.m. machine was traded in on a new one of the same capacity but running the same r.p.m. as the motor and that was what gave me the direct connected idea. This stopped the belt breaking and trouble from reversed polarity.

Belts for Variable Load

OBVIOUSLY a belt should be chosen for the conditions under which it is to work and should be strong enough to carry satisfactorily the greatest tension ever put on it. If the load is steady, the tension is easily calculated from the power to be delivered and the belt speed. If a belt is to transmit 25 hp. at 3000 ft. per min., the pull required will be, $25 \times 33{,}000 \div 3000 = 275$ lb., and this will be the difference between tensions on the tight and loose sides of the belt. This difference will depend on the coefficient of friction between belt and pulley, the width of the belt and the arc of contact between belt and pulley. With high coefficient of friction, wide belt and large arc of contact, the difference between tensions on tight and loose sides will be large, hence the maximum tension, which is that on the tight side, will be less than when the factors mentioned are small and the difference between tight side and loose side tensions is less.

Wide variation is found in the coefficient of friction, depending on the kind of belt, and condition of belt and pulley surfaces. For leather on iron, when dry, Morin found a value of 0.56; with an oily belt, the value drops to 0.15; Towne states that, for usual conditions, the coefficient may be taken as 0.42 but, since there is wide variation in the looseness of the belt and in belt condition, it is probable that a lower value is better, and Reuleaux advises 0.25.

Width of belt and arc of contact with belt speed will determine the square feet of belt that will come in contact with the pulley per minute. For a pulley of diameter d in feet, the circumference is $3.1416\ d$ and this times the r.p.m. will give the belt speed v in feet

per minute. For 180 deg. contact, the value v times w, the belt width in feet, gives the square feet area contact per minute, and this times belt pull per foot of width S, will give the foot-pounds transmitted per minute. Dividing foot pounds per minute by 33,000 gives the horsepower transmitted.

Putting this as a formula,

$$\text{Hp} = (v\ w\ S) \div 33{,}000 = (3.1416d \times \text{r.p.m.} \times w \times S) \div 33{,}000$$

Allowable value of S will depend on the kind and quality of belting, and it is generally more convenient to express d and w in inches, so that the formula is changed to

$$\text{Hp} = v\ w \div F$$

The factor F includes the factors 3.1416, S and 33,000 as well as a divisor to allow for the use of w in inches.

A common assumption is that S = 60 lb. per in. of width for single belt and, for this value, F = 550. Bird, however, states that the tension on the tight side should be not over 60 lb. per in. of width for single belt, 105 lb. for double belt and 150 lb. for triple belt; also that the ratio of tensions in tight and loose sides should be not over 2 on small pulleys, 2.5 on medium size and 3 on large pulleys. This works out that the difference between tensions, or S, should not exceed 40 lb. per in. of width for single belt, 70 lb. for double and 100 for triple belt. With these values, Bird gives the following values for F, arc of contact being 180 deg.

Pulley Diam. in.	Ratio of Tensions	Value of S	Value of F
	Single Belt		
To 8	2	30	1100
8—36	2.5	36	920
Over 36	3	40	830
	Double Belt		
To 14	2	52.2	630
14—60	2.5	63	520
Over 60	3	70	470
	Triple Belt		
To 21	2	75	440
21—84	2.5	90	370
Over 84	3	100	330

For arcs of contact other than 180 deg., the values of F are to be multiplied by the following:

Arc, deg.	220	210	200	190	170	160	150	140	130	120
Multipliers	0.89	0.92	0.95	0.97	1.04	1.07	1.11	1.16	1.21	1.27

Thus for a single belt with contact of 140 deg. on a 12-in. pulley the value of F is $920 \times 1.16 = 1067$ and for a 6-in. belt at 2000 ft. per min. the horsepower which should be transmitted would be:

$$\text{Hp} = 2000 \times 6 \div 1067 = 11.2 \text{ hp.}$$

If the load is steady, the foregoing rules will apply, as the tension on the belt will be steady. But with a pulsating load such as an air compressor, or a saw which may strike knots so as to overload the motor, the belt should be so chosen that it will transmit the largest power required, without overstrain.

For an air compressor, the maximum horsepower may easily be three times the average, the ratio between maximum pressure in the compressor cylinder and mean effective pressure. Transposing the formula for horsepower, $w = \text{hp.} \times F \div v$.

If a compressor calls for 20 hp. average load and belt speed is 3000 ft. a min. on a 16-in. pulley with 130 deg. arc of contact on the motor pulley, the width of single belt called for will be,

$$w = 20 \times 830 \times 1.21 \div 3000 = 6.7 \text{ in.}$$

The maximum power required in the cylinder at the end of the compression stroke may be as high as 60 hp., but with a good flywheel, the maximum power required from the motor may be only 40 hp., the balance being furnished by the flywheel. In this case, the belt width should be $(6.7 \div 20) \times 40 = 13.4$ in.

In the case of a motor, the starting torque, or belt pull times pulley radius, may be 1.5 times that for full load rating and maximum running torque may be 2 to 3 times that for full load rating. If the belt is chosen to carry rated load, it will evidently be too small to carry starting load or overload without undue stretch and wear. If starting is frequent or overload is carried frequently for considerable periods, use of a belt chosen for rated load will result in large belt slip, rapid deterioration and necessity for frequent taking up.

Belts should, therefore, be chosen for the maximum load that will be carried, except that infrequent loads of short duration may be overlooked. It is well to consult the motor manufacturer as to the motor best suited to a particular job, and the belting manufacturer as to sizes of belts and pulleys to be used. Long life and economical operation are of more consequence than first cost.

Where an idler pulley is used on a short center drive, the rapid sharp reverse flexes cause internal wear of belt fibers, hence more rapid deterioration, and a thin belt of greater width than for long center drives will be more durable.

As a summary, essentials for a good belt drive are:

A belt with high coefficient of friction on the pulleys to be used.

Ample width to carry the maximum load with minimum slip and wear.

Provision for maintaining belt tension uniform at the value required to carry the load.

IN THE La Monte forced circulation boiler made in England, heating surface consists of 1-inch tubes arranged as water walls of the furnace, water being drawn from the bottom of the steam drum by centrifugal pumps and delivered to a header to which the 1-in. tubes are connected. Outlet from the tubes is to a second header which delivers to the top of the steam drum. Feedwater is supplied through the economizer and discharged into the side of the steam drum. From that drum, steam passes by gravity through the superheater, which forms the roof of the furnace, thence to the steam header. Advantages claimed are positive circulation, no steam binding strong tubes, and reduction of some 50 per cent in the weight of the boiler. Power required by the circulating pumps is some half of one per cent of the output of the boiler.

EXPANSION of the electric light and power utilities has been on a sound basis and the industry is in a safe position with regard to capacity to meet interest charges, according to the National Industrial Conference Board. Increases in the electric light and power companies' funded debt and interest charges have been accompanied by adequate advances in operating revenues.

Underground Pipe Line Refrigeration

By R. H. Switzler[1]

DEVELOPMENT OF REFRIGERATION into the systems of underground refrigerating pipelines, served by central power station plants, finds expression in four cities in the United States, namely, Boston, New York, Los Angeles and St. Louis. The pipelines in Boston and New York furnish brine service, wherein cold brine is circulated in underground mains from a central refrigerating plant; in St. Louis and Los Angeles this service is by direct expansion, wherein ammonia is circulated from the central refrigerating plant.

In point of refrigeration delivered to customers, measured by the revenue produced, the system in Boston is probably the most important; however, in the point of the physical area covered, the refrigerating underground pipe line in St. Louis is believed to be the largest in existence, with excellent possibilities for future development, in view of the modern trend towards air conditioning, which has become one of the specialties of the St. Louis system.

The St. Louis pipeline originated in 1890 under a franchise granted by the city and taken over by an entirely new corporation, the St. Louis Refrigerating & Cold Storage Co., organized and incorporated in May, 1899. The present company operates two other enterprises of business in the field of refrigeration—all three from one power plant. In addition to its refrigerating pipeline, it operates cold storage warehouses with total capacity of 2,500,000 cubic feet and an ice plant manufacturing 200 tons of ice per day.

An area of approximately 25 city blocks north to south and 25 city blocks east to west covering what is known as the "downtown business section of the City of St. Louis," is served. The present corporation has laid and now operates a total of approximately 8 miles of refrigerating pipes in the city of St. Louis, and the distance from the main plant to the farthest point served is about 2.5 mi.

Operation of this pipeline has entailed much pioneering work in the field of refrigeration and today one of the most important features of construction is the fact that the lines are not laid directly in the earth but are placed in a vitrified tile duct which makes possible a very simple construction in the streets. Expansion and contraction of the pipe become an important factor and at times these early lines would pull apart with the resulting loss of a large quantity of ammonia. This problem has been solved by the use of expansion joints, each joint situated so as to take care of at least 3 in. of travel in every 300 to 500 ft. of pipe.

Another vital change made in the construction of these pipe lines is that of welding all pipe joints with the exception of fittings and cross-connections which are located in manholes constructed at from 300 to 500 ft. apart. Before welding was commonly accepted and used for pipe line construction, leaks were frequently occurring which not only entailed the loss of ammonia but excessive costs of maintenance and reconstruction. Before the use of welded joints, when a new customer was connected to the line it was necessary to run a new line from the closest manhole to the customer's premises, whereas today, by means of welding, it is possible to connect a lateral directly into the main line at the closest point available. This lateral is extended to the curb line in front of the customer's premises and stop valves are placed in a small manhole constructed in the sidewalk. These valves are used for shutting off the service to the customer whenever the occasion arises, either through normal operation or through emergency.

One of the lines installed is the vacuum line by means of which it is possible to remove all of the ammonia, whether liquid or gas, from any section of the mains or from the customer's premises. This affords a simple means for making connections or changes and for handling any emergency. This vacuum line is cross-connected into the gas and liquid lines at all manholes and stop boxes.

Pipe lines, placed in a tile duct, are supported on rollers set at every 10 ft. The hangers which carry the rollers are constructed so as to permit such water as may enter the duct to drain to a manhole in which are located drains to a nearby sewer. In the tile duct three lines are placed; the liquid anhydrous ammonia line feeding the customer's apparatus, where it is expanded through automatic valves; the gas line returning the gas to the plant, and the vacuum line heretofore mentioned. In some instances a second gas line is added, making it possible to operate at different back pressures.

Loss in transmission of refrigeration in the liquid and gas lines is practically at zero as the liquid and gas remain at ground temperature. Consequently, no insulation on these lines is used.

Among the difficulties encountered are the problem of super-heated gas returning to the plant and troubles with oil entering into the ammonia. Abnormal pressures are encountered at times due to the pipe lines

[1]St. Louis Refrigerating & Cold Storage Co., St. Louis, Mo. This is part of a paper presented before the Seventh International Congress of Refrigeration at The Hague, June, 1936.

passing through heated zones in the ground, caused by underground steam lines, or due to the pipe lines having been placed too close to the surface of the street—sometimes unavoidable due to underground obstructions. This problem of gassification due to abnormal heat is met through correction of pressures or by sub-cooling the liquid, both developments reached through actual experience in operation.

Another interesting feature, not taken into account originally, is the fact that the lines in use ultimately reach their limits in capacity, limits to the extent of preventing the gas from traveling through the gas line due to having reached the saturation point, not only in length of pipe but in the velocity necessary to take care of the loads being encountered. This condition was first remedied by adding more lines and increasing their size; later on after several years' operation by installing a booster plant near the central section of the total line. This Sub Plant relieved this condition and made it possible to handle more than twice the previous load.

The most recent problem of moment was a rapidly increasing air-conditioning load; to meet it with greatest economy in installing underground mains to the Sub Plant an extra gas line was run along with the customary liquid and gas lines, in order by this means to be in a position to handle two different back pressures, one for the regular work and one for the air-conditioning loads. This was an important development of the Sub Plant, namely, the maintenance of a higher back pressure resulting in a reduction in cost of operation. It must be remembered that the cost of manufacturing refrigeration and distributing it through underground refrigerating pipe lines must be kept at a minimum in order successfully to cope with the competition of isolated compressor operation. This is axiomatic of all central station work.

In furnishing refrigeration to a customer, a contract is submitted in which the only requirement laid on the customer is that he pay for the service—either on a specific flat rate or on a metered basis at so much per ton of refrigeration consumed. In turn the pipe line operator guarantees to take care of all the customer's refrigerating requirements and problems and to facilitate this handling with the best results a staff of inspectors is maintained, who make a continuous round day and night of customer's premises to inspect conditions and regulate temperatures where necessary. In recent years this service has been greatly enhanced by the use of automatic expansion valves with thermostatic control and automatic devices for preventing waste of refrigeration. In many instances, particularly for air-conditioning loads, automatic controls have been designed so that any change in condition is immediately corrected.

Buick Steps Out

(Continued from p. 681)

As mentioned earlier the coal handling facilities of the old plant are unchanged except for altering the east coal spout from the weigh larry and adding 4 t. individual hoppers. All units are, or will be as they are put into service, controlled with one master and four individual boiler panels by a Hagan combustion control system which was described in detail on page 161 of the March 1936 issue. Each boiler panel has a Bailey multipointer draft gage, four pen temperature recorder, boiler meter and coal feed indicator in addition to the Hagan controls and push button motor starters. In addition the boilers have Copes feedwater regulators, Consolidated safety valves and Diamond soot-blowers. As now installed the single loop superheaters are designed to give a superheat of about 50 deg. F., just sufficient to insure dry steam at the point of use. The superheater headers are, however, drilled so that additional elements may be installed quickly if the pressure is raised and a top turbine installed.

Due to the diversified sources and variations throughout the year, the feedwater system is particularly interesting. In the winter months there is a relatively small return from the hot water heating system, 5 to 10 per cent of the total boiler feed. About 30 per cent of the total feed is returns from the steam heating system, but this is contaminated with oil and with raw water injection to the vacuum pumps. The pure returns are heated, but not treated, in the condensate section of the Cochrane hot process softener and heater installed in the original plant. Capacity available will handle 28,000 gal. per hr. of pure returns.

Contaminated returns are heated and treated with lime and soda ash in the treating section of the same softener and are filtered before delivery to the boiler feed pumps. The capacity available is 32,000 gal. per hr. Makeup is taken from the spray pond. This pond acts as a receiver for raw city water used for cooling in the air compressors, on the test block, etc., and the level is maintained automatically by a float valve from the city water system. The city water ranges from 264 to 372 p.p.m. hardness, but due primarily to the condensate from the jet condensers under the turbines, the spray pond hardness usually runs about 40 p.p.m. less than raw city water. The makeup taken from the spray pond is passed through a new 100,000 gal. per hr. Cochrane hot process water softener just installed outside of the power plant.

These three types of feed are mixed in the lines before delivery to the boiler feed pumps, the equipment being so arranged that preference is given to the use of the softer waters. Spray pond makeup is admitted to the treating tank only as required to maintain the desired reserve storage. To handle this feedwater two De Laval steam driven pumps have been installed in the auxiliary bay. Each unit is rated at 1300 g.p.m. against 700 ft. head and driven at 2150 r.p.m. by 307 hp. turbines.

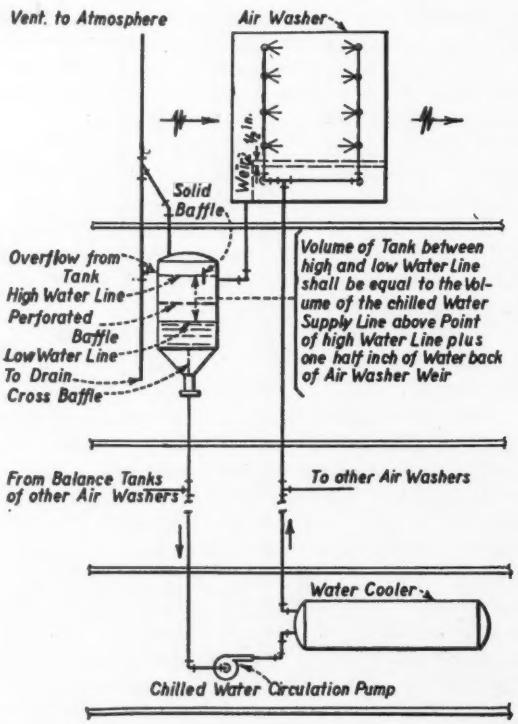
Considering the job as a whole; provision for heat balance regardless of future changes in manufacturing process; provision for further expansion of the boiler room; provision for high pressure operation later; low cost of the installation with practically no building changes and the fact that the changeover is being successfully made without interruption of production makes this an outstanding example of industrial power plant modernization. The engineering work and installation was handled by the Engineering Department of the Buick Motor Co. under the direction of Frank Elwell, Works Engineer, and Riley Drewyer, Supt. of Power Plants.

Chilled Water Distribution of Air Conditioning Systems

IN SMALL air conditioning or cooling installations, refrigeration is sometimes applied through direct expansion but in larger plants chilled water is often used as a heat transfer medium and is pumped from evaporators generally located in basements through spray humidifiers located throughout the building and often in attics. Some of the problems met with in this relatively new branch of engineering were discussed by E. W. Goodwin, Senior Mechanical Engineer, U. S. Treasury Dept., in a paper Specifications for Air Conditioning presented at the 31st Annual Meeting of the A.S.R.E. Dealing specifically with the problem of chilled water distribution, the author made the following remarks:

It has been interesting to observe the different ways in which the several engineers have attacked the problem of chilled water distribution. Each has apparently realized that an air washer is a first class aerator and that a descending column of air charged water having a normal hydraulic gradient somewhere near the top of the building can cause a lot of havoc when the flow reverses and it becomes a geyser, fed at the bottom perhaps by several other columns that continue to descend.

Some engineers have boldly stepped around the danger by returning all of the dehumidifier overflow to an open or vented tank located near the chilled water circulating pumps. Except in the case of water vapor refrigeration, where the vacuum required in the evaporator puts a positive head on the chilled water returns of no value whatever, the vented tank, while rendering the return lines free from the danger of causing a cascade of water down the stairways, does add a static head on the chilled water pumps equal to the elevation of the dehumidifier overflows above the pumps.


Vent. to Atmosphere
Air Washer
Solid Baffle
Overflow from Tank
High Water Line
Perforated Baffle
Low Water Line
To Drain
Cross Baffle
Volume of Tank between high and low Water Line shall be equal to the volume of the chilled Water Supply Line above Point of high Water Line plus one half inch of Water back of Air Washer Weir
From Balance Tanks of other Air Washers
To other Air Washers
Water Cooler
Chilled Water Circulation Pump

Diagrammatic representation of a chilled water circulating system

With few exceptions our engineers have advocated the conservation of this head and, in one case, involving about a dozen dehumidifiers located in an attic, a satisfactory installation was made by locating a small balance tank near each dehumidifier. These tanks were provided with a cone shaped bottom outlet to the return piping, an inlet (near the top) from the dehumidifier, an overflow just about level with the inlet and a vent at the top.

The volume in the tank between the overflow and a point sufficiently high above the outlet to prevent cavitation at full flow was made just equal to the volume of that part of the chilled water supply piping located above the low water line in the balance tank. The return piping from each balance tank to the chilled water circulating pump was then so sized that the combined system of mains and branches would equalize the friction. Thus at full flow the elevation of the water in one tank would not vary from that in any other by more than one foot. Obviously at any other rate of flow the variation would be less.

In practical operation these tanks gradually accumulate the excess moisture from the air until they overflow. As the downward velocity through the tank is low, and as the inlet is suitably baffled the entrained air is vented through the top. When the system is shut down there may be, of course, no further overflow, but if the check valves on the circulating pumps leak, or if water in the overhead lines continues to run into the dehumidifiers, the overflow continues until equilibrium is established. However, when the pumps are again started there is no danger of air binding the system, because water again enters the tanks from the dehumidifiers before the low water line in the tanks can be reached. Water rotation in the tank outlet cone is prevented by a cross inserted in the cone.

This system of return piping has worked satisfactorily in two instances where about 11,000 g.p.m. of water are handled. The static head on the pumps is reduced to a practical minimum with a consequent saving over a gravity return of the power required to overcome the full static head, and the amount of refrigeration required to absorb the heat imparted to the water by the pumps when producing the full static head.

Check Determinations of Grindability of Coal

By W. A. SELVIG*

Five laboratories cooperate in conducting check tests on four methods of grading the grindability of coal. Bureau of Mines Method and Hardgrove Method recommended as optional.

TESTS TO BE DESCRIBED were conducted under the sponsorship of Subcommittee VII on Pulverizing Characteristics of Coal, a subcommittee of Committee D-5 on Coal and Coke, American Society for Testing Materials, with a view to evaluating various laboratory procedures for testing grindability of coal in connection with commercial pulverization of coal for use as powdered fuel. The subcommittee, selected for test, four methods that had been developed during the past few years for testing grindability of coal and were being used by coal-testing laboratories in the United States and Canada. These methods are: Bureau of Mines method, Cross method, Fuel Research Laboratory method, and Hardgrove method. The Subcommittee agreed that the grindability tests should be made on five coals selected to cover a wide range of hardness and the Pittsburgh Experiment Station, Bureau of Mines, was asked to direct the investigation and to prepare representative samples of the coals.

Coals selected were a Pocahontas coal to represent soft coals, a Pittsburgh bed (Pennsylvania) coal and an Illinois coal to represent medium-hard coals, and a soft variety of anthracite and a hard variety of anthracite to represent hard coals. Each lot of coal sampled was crushed to pass a ¼-inch square-mesh sieve. The crushing was done in successive stages of crushing, sieving, and crushing of oversize to prevent the formation of large amounts of fine coal. The crushed coal was mixed and reduced in quantity by the cone and long-pile method.

Table 1 gives the source and analyses of the five coals. Each laboratory was instructed to sieve the coal samples on a No. 30 sieve, to reject the undersize, and to make the grindability tests on that portion remaining on the sieve. Size tests on one set of the samples gave the following percentages of coal remaining on a No. 30 sieve: Coal 1, 86.5; coal 2, 85.5; coal 3, 89.0; coal 4, 92.1; and coal 5, 95.6.

Each laboratory was sent detailed instructions regarding the procedure for each method of test and was instructed to make the grindability determinations in duplicate. Some of the laboratories were not equipped to determine grindability by all the methods.

Bureau of Mines Method

The Bureau of Mines method was developed by Yancey, Furse, and Blackburn at the Northwest Experiment Station of the Bureau of Mines. Briefly, this method determines the relative amounts of energy necessary to pulverize different coals by placing a sample of 500 grams of coal sized between No. 12 and No. 200 sieves in a ball mill and finding the number of revolutions required to grind it so that 80 per cent of the sample passes a No. 200 sieve. The mill is a cylindrical steel mill 8 inches in length and 8⅛ inches in diameter, inside dimensions, and contains a charge of 100 steel-ball bearings, each 1 inch in diameter. To prevent slippage of the charge three steel lifters or ribs are fastened longitudinally at 120 deg. intervals to the inside wall of the mill. The mill is rotated in a horizontal position about its cylindrical axis at 40 r.p.m. This method is published as a tentative standard of the American Society for Testing Materials, under the designation "ball-mill method."

Cross Method

The Cross method was developed by B. J. Cross in the laboratories of the Combustion Engineering Corp. A sized sample of coal is ground under prescribed conditions in a ball mill and the grindability calculated from the amount of new surface produced. In the method as used by Cross a charge of 200 grams of coal crushed to pass a No. 10 sieve was taken as a sample. Martin Frisch, chief engineer, Boiler and Pulverizer Division of the Foster Wheeler Corp., reported to the subcommittee that samples thus prepared contained enough fine coal to mask their true pulverizing characteristics; he therefore recommended that the grindability sample be sized between No. 10 and No. 20 sieves. This modification of the Cross method was incorporated in the test procedure as sent the laboratories.

Fuel Research Laboratory (F.R.L.) Method

The F.R.L. method used in the grindability tests is a revision of the method developed by Baltzer and Hudson of the Fuel Research Laboratories, Canada Department of Mines. Five hundred grams of coal crushed to pass a No. 10 sieve is ground in a ball mill under prescribed conditions and the grindability calculated from the amount of coal ground to pass a No. 100 sieve.

Hardgrove Method

The method developed by Hardgrove, research engineer, Babcock & Wilcox Co., determines the relative grindability or ease of pulverizing coals compared with a standard coal, the grindability rating of which is chosen as 100. A sample of 50 grams of coal sized be-

*Supervising chemist, Pittsburgh Experiment Station, U. S. Bureau of Mines. This is an abstract of U. S. Bureau of Mines Report of Investigations 3301.

tween No. 16 and No. 30 sieves is ground under prescribed conditions in a specially designed miniature pulverizer, and the new surface is determined by a sieve analysis. The grindability is reported as the ratio of the new surface produced to the new surface produced with the standard coal with a grindability rating of 100. This standard coal is an easily pulverized low-volatile bituminous coal from Somerset County, Pa.

Relative ratings of the grindability of the five coals, as determined by each laboratory, were calculated by assigning a grindability value of 100 to coal 1, the most readily grindable and expressing the grindabilities of the other four coals as percentages of the value assigned coal 1.

Each laboratory arranged the coals in the same relative order for the Bureau of Mines, the Hardgrove, and the Cross methods, except that one laboratory reported the same relative ratings for coals 2 and 3, using the Cross procedure. In general, there is poor agreement among the laboratories as to the relative rating numbers assigned the coals using the Cross method. One laboratory reported that considerable slippage of the charge in grinding coals 4 and 5 was evident from the sound of the material in the mill. This probably varied for the different coals, and if so the grinding efficiency of the mill would vary from coal to coal.

TABLE I—SOURCE AND ANALYSIS OF THE FIVE COALS

Coal	Moisture	Volatile matter	Fixed Carbon	Ash	Sulphur	B.t.u.
1	0.9	18.3	75.4	5.4	0.5	14,740
2	1.5	33.7	57.9	6.9	.9	14,050
3	8.9	37.4	40.1	13.6	4.2	11,090
4	2.5	6.4	81.8	9.3	.9	13,560
5	3.7	2.9	84.4	9.0	.5	12,990

No. 1 was a low-volatile, bituminous coal from Pocahontas No. 3 bed, McDowell County, W. Va.
No. 2 was a high-volatile A bituminous coal from the Pittsburgh bed, Fayette County, Pa.
No. 3 was a high-volatile B bituminous coal from No. 6 bed, St. Clair County, Ill.
No. 4 was an anthracite from Bear Valley Colliery, Northumberland County, Pa.
No. 5 was an anthracite from St. Nicholas Colliery, Schuylkill County, Pa.

Laboratory A obtained the same grindability values for coals 2, 3, and 4 using the F. R. L. method. According to two laboratories, B and E, coals 2 and 3 would have practically the same grindability characteristics. Laboratory B rated coal 4 an anthracite, as more readily grindable than the two bituminous coals, 2 and 3; probably slippage of the charge occurred. The F. R. L. method and the Cross method use the same porcelain jar ball mill with a smooth interior; in the former sillimanite balls are used for grinding and in the latter steel.

Another laboratory, D, used a mill rotation of 55 to 60 r.p.m. for the Bureau of Mines, Cross, and F. R. L. methods, because the mill carrier available was equipped with a direct drive and it was not feasible to vary its speed. The procedure for the Bureau of Mines method specifies a mill rotation of 40 r.p.m., the Cross method between 70 and 80 r.p.m., and the F.R.L. method 70 r.p.m. The writer has no data that show what effect the variation of mill rotation would have on the grindability values reported by Laboratory D.

Still another laboratory, C, stated that the volumetric capacity of different mill jars as supplied by the manufacturer and used in the F. R. L. and Cross methods might vary and that such variations in capacity of different jars might affect their grinding efficiency. No data are available as to the effect of such variations on the results of these grindability tests.

To make the variations between duplicate determinations on the same coal comparable for the different methods, these variations are given as percentages of the lower grindability values. These variations indicate the ability of a laboratory to check in duplicate determinations on the same coal. Data and the tests showed that the Bureau of Mines and the Hardgrove methods are the most precise and that there is no practical difference between them in this respect. The F. R. L. method shows larger variations than these two methods, but duplicate results are closer than in the Cross method. Two of the laboratories obtained better check results by the Cross method than did the other three laboratories.

Duplicate determinations for all the laboratories and methods were compared to indicate how closely different laboratories can check on the same coal by the same method. In this respect the Bureau of Mines and Hardgrove methods are superior to the other. The F. R. L. method ranks next, but it shows large differences for the anthracites, 4 and 5, especially coal 5, which is a hard variety. The Cross method gave relatively large differences for all of the coals tested.

TABLE II—RELATIVE RATING OF THE FIVE COALS BY LABORATORY AND TEST METHOD

Laboratory and coal number		Relative rating based on coal 1=100 Bureau of Mines Method	Cross Method	F. R. L. Method	Hardgrove Method
A	1	100	100	100	100
	2	56	51	64	67
	3	51	45	64	60
	4	44	31	64	51
	5	31	13	40	36
B	1	100	100	100	100
	2	61	59	62	64
	3	54	59	61	60
	4	50	28	66	48
	5	35	14	13	35
C	1	100	100	100	100
	2	56	43	63	64
	3	49	19	59	56
	4	45	12	57	51
	5	31	5	11	37
D	1	100	100	100	
	2	60	48	65	
	3	51	7	61	
	4	47	2	35	
	5	31	1	3	
E	1		100	100	
	2		50	60	
	3		32	59	
	4		8	46	
	5		1	2	

Two of the laboratories reported the total time required to make a single determination by each of the methods. This time includes preparation of the sample, grinding, sieving, weighing, and calculating the results. One found that the Bureau of Mines method required 5½ hr., the Cross method 1¾ hr., the F. R. L. method 2 hr., and the Hardgrove method 1½ hr. The other reported that the Bureau of Mines method required 4½ hr., the Cross method 1½ hr., the F. R. L. method 2½ hr., and the Hardgrove method 2 hr.

At a subsequent meeting of the Subcommittee VII the results of the grindability tests described above were considered carefully, and the subcommittee recommended the Bureau of Mines method and the Hardgrove method as optional methods of test. The subcommittee decided that these two methods were superior to the other methods tested both in accuracy and ability to duplicate results in the same and in different laboratories. The Bureau of Mines method has the advantage of low cost of equipment, whereas the Hardgrove procedure requires less time.

Readers' Conference

Fighting Spontaneous Combustion of Coal

THERE SEEMS to be a widespread opinion among operating engineers that when fire starts in coal in storage whether outside or in the bunker, that the use of water is futile. Some even think that water makes it heat more, but this later opinion is probably caused by the fact that wet coal throws a lot of vapor during the first stages of heating while dry coal may not give any indication until actually on fire.

Since the use of water is eschewed, the ordinary recourse when a fire starts is to remove the coal and burn it. But such transfer of coal is costly and may be accompanied with a great deal of inconvenience. As for example in one instance when the coal from a bunker had to be dumped on the boiler room floor, covering all equipment with coal dust, then it was wheeled a short distance and dumped outside, then wheeled again to the tracks, then loaded on railroad cars and finally transferred to another bunker to be burned. In heating plants, if fire develops during the off-heating season, it cannot be burned.

I have successfully used water in putting out coal fires and consider that method the most practical when the coal that is on fire cannot be burned immediately or when the transfer is costly or inconvenient. The reason why many engineers are doubtful of the efficacy of the use of water is because they have probably tried to put out the fire in that way and apparently succeeded but a day or so later it started again. The explanation for this is that it takes a lot of water to put out the fire and the water must be left running for some time after the fire is apparently out.

In some cases, even when a great deal of water will not completely put out the fire it will certainly diminish appreciably the damage that would otherwise be done. In one case that has come under the observation of the writer, some several thousand tons of Kansas coal in a storage yard caught fire and the fire was spreading much faster than it could be removed to be burned. The operators had previously used water and had come to the conclusion that it was useless. Although it was realized that the loss would be serious, it was felt that nothing could be done about it. By the use of an excessive amount of water, however, the fire was brought under control in a couple of days and, although there were spasmodic fires until the entire storage was burned, these were put out as they occurred, and the loss was reduced to a minimum.

In another case, a heating plant bought about 300 t. of Indiana coal during the summer months which were placed in the two bunkers. In two or three weeks the coal gave signs of heating which increased from day to day and it was feared that it would result in fire unless the temperature rise was checked. Water was turned on both bunkers and allowed to drain from the bottom. In a few days the temperature rise of one bunker was checked but that of the other kept rising in spite of the water. By restricting the outlet as much as could be done and increasing the flow of water until there was more water going in than draining out it was possible to flood this one bunker and in this way the development of fire in both bunkers was checked.

Chicago, Ill. N. T. PEF.

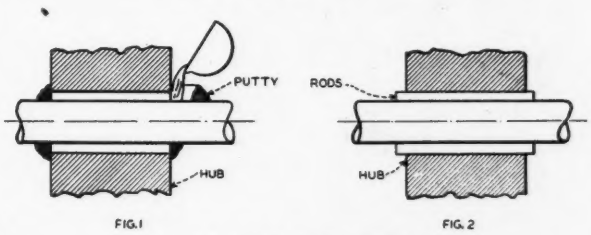
Bushings Quickly Made

WHEN STANDARD BUSHINGS are unavailable and you are in urgent need of one or more such bushings, there usually is a way in which to make an emergency bushing that will serve the purpose. This is one of the advantages of mechanical drive.

Babbitt and lead often lend themselves to an occasion of this kind better than anything else.

Nearly every mechanic knows how to babbitt a bearing; at least he should know.

To apply a babbitt or lead bushing, all that is necessary is to support the pulley in any convenient way so that it is in its correct position around the shaft. That is, it must be concentric. Then by means of putty or any other suitable material build dams around the openings and arrange the mould so that the metal can be poured. The method is so obvious that detailed explanation is unnecessary. Then pour the metal about as indicated in Fig. 1. That's all there is to it.



Figs. 1 and 2. Methods of making bushings

For split pulleys, if it so happens that the bushing must be exactly one eighth of an inch thick, or a quarter inch, and if you have in stock some round iron rods an eighth or quarter inch in diameter, cut the rods to a length slightly greater than the length of the pulley hub. Then use the rods for bushings placed side by side to fill the entire space between the shaft and pulley as shown in Fig. 2.

Square stock is better than round stock for this purpose because the round pieces will act like rollers in a roller bearing if the pulley is not bolted up sufficiently tight to prevent such motion. For this reason rough round pieces are better than smooth. Use square or rectangular stock in preference to the round if you have the former.

Sometimes the quickest way is to use strips of hardwood laid side by side around the interior of the pulley just as explained above for the rods. Wood is more easily reduced to the proper size than metal. Where there is ample contact surface between the pulley and shaft wood generally serves the purpose just as well as metal.

Newark, N. J. W. F. SCHAPHORST.

Fatal Accident When Welding a Boiler

A FATAL ACCIDENT occurred to a welder due to his gripping the electrode holder under the arm pits since it could not be laid down on the workpiece. The result was that his body was severely burned and the injuries proved fatal. On examination his clothing was found to be good and strong, but it had become damp through perspiration which had lowered its insulation, so that it was not resistant to the comparatively low potential of 90 volts. This accident shows that the open circuit voltage of a welding machine up to 90 v. a.c. or 110 v. d.c. may be dangerous. Precautions should be taken when welding in damp places or if the welder is subject to perspiration. Moisture lowers the insulation resistance of clothing; a welder's clothing should always be dry and any parts of the electrode holder likely to become alive should be covered with rubber insulation. When welding in a boiler all men perspire to some extent some men seriously, this largely affects the under clothing, welders should always wear a stout dry outer jacket which can be changed as soon as it shows signs of dampness or discarded as soon as it wears.

Kent, England. W. E. WARNER.

Improving Packing Performance

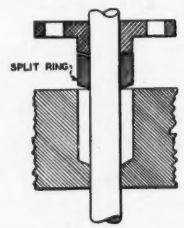
IN A LOCAL plant the operators experienced plenty of trouble with the control valve glands of the large turbines. The control valve rods move up and down according to the demand for steam. Steam pressure was high and the steam was superheated considerably. Several different brands of packing were tried out but all of them, after a week or so, began to blow steam and the packings got a bad name in consequence.

One of the operators approached the problem from a different angle. He knew the packings could not be at fault as he had used them in a wide field for years. He saw that the rods were in good condition. He found that, while the boxes were of ample depth (over 2 in. for a 1-in. rod) the followers which compressed the packing were but ½ in. long. This meant that the natural resiliency of the packing was such that it could not be adequately compressed by such a shallow follower and leakage ensued.

There were two rods on the unit. The operator made two rings of mild steel, 1 in. long, bored to loosely fit the rods of an outside diameter slightly less than the stuffing boxes. In other cases the length of the ring would be dictated by the length of the stud, etc. The rings were sawed through on the bias to make two half sections of each and, when next the unit was shut down, the followers were slacked off, the split rings inserted around the rods, resting on the packing and below the followers.

Tightening down the followers allowed good compression of the packing, the insertion of an extra turn and, when the unit was in use, still more compression when needed with ample space still available for further tightening, if required.

The present packing, one of the brands previously



Stuffing box showing split ring

condemned, has now been in the glands concerned in continuous operation for over a year and no adjustment has been made during that time. What is more to the point, it is still tight.

Rutherford, N. J. MARK BELL.

Sprinklers & Water Pockets

TWENTY-FIVE OR MORE years ago, I was called in to explain why a small high speed engine hammered and clattered. The engine plant was in a (for those days) large department store and elevator service was furnished by plunger elevators, served by large duplex steam pumps. The mechanical engineer who drew up the plant had copied, part for part, a similar plant in a distant city but the climatic conditions and the size of the store were identical. Engines in the original plant operated so smoothly that a visitor would hardly suspect that they were in motion, but one of this pair could, at times, be heard in the store.

It was in the late autumn and the atmosphere was decidedly chilly and as I entered the plant I noticed that we didn't have to open a door; the side and end walls of the boiler room were down. My friend informed me that the machinery had come through the openings but that the mason would begin closing in another week. I asked him if he didn't realize that it was 32 deg. F. outside and that condensation must be tremendous. Then I made another discovery. Not one

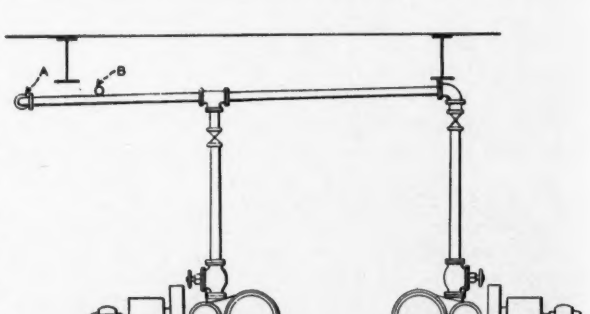


Fig. 1. Original arrangement. B is a 6 in. sprinkler line, A a 6 in. ell in the steam line which pitched uphill both ways, that is toward the back and toward the engine resulting in an annoying and dangerous pocket

inch of the piping, fittings or big cylinders on the elevator pumps was covered.

"You can see for yourself," Bill said, "that the condensation is very little. Take this formula and work it out."

Here's the formula; I've kept it for all these years.

$$C = (S—t)\ 1.8 \div H$$

In which,

C = condensate in lb. per hr.
S = sensible heat in steam at given pressure
t = temperature of room.
1.8 = B.t.u.'s required per square foot per hour.
H = latent heat of steam at given pressure.

After figuring all the uncovered surfaces in the plant this rule failed to show any great loss and goes to prove that the finest of rules are, at times, a bit misleading.

When I entered the engine room the No. 1 unit (Fig. 1) was beating a merry tattoo and my friend Bill informed me that he would immediately get in touch with the engine builder and read the riot act. As it happened, the units were built in New Jersey by one of the brightest mechanics of his day and I knew that the engine when it left the factory had been mechanically correct. Then I saw light. A 6 in. sprinkler line ran alongside a deep steel girder and some bright light of a steam fitter had pitched the 6 in. steam line supplying the engines down hill away from the engines, to an elbow and then up hill to the boilers.

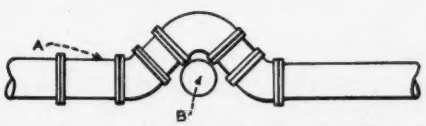


Fig. 2. Steam line B raised 6 in. and bridged by sprinkler line A with two 45 and one 90 deg. ell

When I called Bill's attention to this mess he fired right back, "Well, you can't disturb a sprinkler line and you'd ought to know it by this time." Then a break was given me. Bill was taken sick and had to be rushed home. I saw the fire chief and told him I wanted to shut off the sprinklers at Rush & Holt's for 2 hr. Sunday morning. He promised to have a fireman patrol the store and to be ready for any emergency.

Then I had the boss fitter get out a cross over fitting to carry the sprinkler pipe over the steam line. Then cutting 4 in. from the riser at No. 2 unit allowed a beautiful pitch from the boilers to the No. 2 unit. It was necessary to put a longer nipple in the space above No. 1 roof valve but the idea was to carry the steam line as high as possible. You have guessed right; there was no more clatter!

Lawrence, Mass. C. J. WILDER.

Winter Difficulties with the Crane

THE BRIDGE CRANE is more likely to have its troubles in the winter than at any other time, although it is of course never exempt. The plant which has a good chief electrician to whom the general oversight of the crane can be intrusted is fortunate, since most of the troubles to which they are subject either have an electrical slant or may be most conveniently overcome by some electrical application. The exposed crane is of course the worst in winter. In some cases the crane cab is not sufficiently heated to allow the operator enough warmth. Under such conditions he cannot be expected to operate the controls or spot a load so efficiently as he could if he were reasonably comfortable. Electrical heating units installed in the cab are of course the answer to this.

Icy rails no longer hold the hazard they once did, for the crane that is properly equipped. The day when a man had to crawl the tracks with a sand bucket is past. The machine can now be fitted, and in many cases is fitted with a sanding device for the rails that is electrically operated by a push button from the cab. The principle of operation is the solenoid or electromagnet, pressure on the button closing a circuit which energizes the magnet to operate a sand-releasing mechanism on a sand hopper that travels just over the rail.

In extreme cold weather, trolley wires on cranes sometimes shrink enough to cause them to snap. Where this occurs it is evident that some means must be provided for releasing the excess strain on the wire. The longer the wire, the more liable it is to snapping in cold weather. We read of one instance in which a compression spring mounting for the trolley wire dead end was arranged in such manner that excess tension set up in the wire simply compressed the spring, so that shrinkage and elongation set up by changes in temperature were taken care of automatically.

Winter days are of course dark days, relatively, and this affects the operation of all cranes operating under cover. The craneway cannot be lighted by ordinary methods, of course. It is necessary for good results that lighting units be located high up in the craneway, in order that they do not interfere in any way. For this purpose, just any lighting reflectors will not do, if the light is to be efficiently directed. There are, of course, reflectors made for such high mounting, which are particularly adaptable for use in craneways and similar locations, and their use should not be overlooked.

Peoria, Ill. JOHN E. HYLER.

Testing Refrigerator Joints

THE JOINTS of small tubular refrigerator units are usually tested with compressed air. When leakage is detected the air pressure should be released and the remaining air blown out with nitrogen before repairing the defect by welding. A slight leakage was found in a unit and this was sent to the welder for repair without releasing the air pressure. The welder being new to the work did not know this and commenced welding before relieving the air pressure. The result was that a piece of soft metal was blown out injuring the welder's eye.

Kent, England. W. E. WARNER.

Early Virginia Industries

An old lime kiln has been uncovered in the steep clay bank of the James River within the boundaries of Colonial National Historical Park, Virginia. In the kiln remained a quantity of oyster shell lime, well tempered and as soft as when prepared, three centuries ago. The kiln is a primitive "fire kiln." Charcoal embers denote the type of fuel in use. Only a few yards distant a similar kiln was later discovered.

Selenium vs. Photoelectric Cell

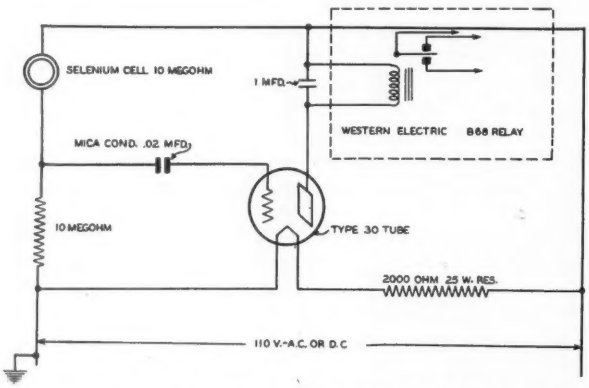
Q. THE ACCOMPANYING circuit is, at present, being operated with a ten megohm selenium cell. Will it be possible for me to use a photocell in its place and if so what type? Any suggestions will be appreciated.

Merrill A. Radamaker.

A. Yes, it would be quite possible to substitute a photoelectric cell for the selenium cell which is now being used in the circuit, though, probably, some changes might have to be made in the circuit constants. The value of the series resistance may have to be changed.

Unless there is some particular reason for doing so, however, we would not suggest such a change. If the speed response of the selenium cell now incorporated in the circuit is sufficient for the application for which it is now being used, there would be no particular advantage in replacing it with a photoelectric cell, either of the vacuum or gas filled types.

If the selenium cell you now use is of a modern type, it should compare very favorably in performance with other light sensitive cells for most purposes. For some purposes the modern selenium cell is superior to



The question is: can the selenium cell in this circuit be replaced by a photoelectric cell

other forms of light sensitive elements. They are rugged, stable and highly sensitive. For purposes where a simple on-and-off function only is required and where speed or response is not an essential requirement, the selenium cell has distinct advantages.

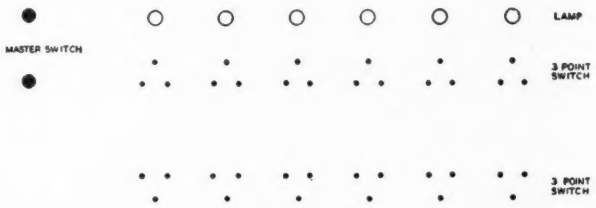
Judging from the circuit and from the resistance which is indicated, the selenium cell used in your circuit probably varies between 10 megohms when dark and one or three-quarters megohm when light and under the conditions of anode potential which you specify the current through the cell varies between 5 and 10 microamperes. This is quite small for a selenium cell, some of which, such as the F.J. 31 made by the General Electric Co. for example, have maximum current ratings of as high as 0.5 milliamperes (500 microamperes).

The current of 5 to 10 microamperes compares favorably with the rating of the P J 22 photo tube which has a maximum anode current rating of 20 microamperes with its maximum sensitivity at an anode voltage of 90. It is evident, then, that this photo tube could be substituted for the selenium cell you are now using. This tube, the P J 22, with incident illumination of 1 lumen and an anode voltage of 110, delivers an anode current of 5 microamperes. This current is sufficiently within the necessary range for applying proper grid bias to the type 30 tube which is used as an amplifier in your circuit.

The circuit itself we believe does not need to undergo any fundamental changes, although there are a number of different types of circuits in which the elements you specify could be used. If the substitution is made, however, it might be necessary for you to try several resistance values for the grid circuit resistor in order to obtain the most favorable operating condition. The operating conditions, of course, will vary with the plate potential on the 30 tube but with the 110 volt value which you indicate on your diagram the grid bias voltage on the 30 tube should be in the neighborhood of —8 volts.

Lighting Circuit Problem

IN THE ACCOMPANYING diagram are shown six lights each one of which is controlled individually by two 3-point switches. I have also indicated a master switch,



a single pole switch. I wish to arrange the circuit so that the single pole master switch will turn on all six lights regardless of the setting of the 3-point switches and so that when the lamps are turned on by the master switch, they cannot be turned off by any of the 3-point switches. Can this be accomplished?

Brooklyn, N. Y. G. E. G.

Combustion Control

EFFECTIVENESS of combustion controls for gas-fired boilers was emphasized by L. S. Reagan in a paper before the Industrial Gas Section of the American Gas Assn. After analyzing the losses from various causes, he states that, with simple controls where load is from 25 to 100 per cent of boiler rating, CO_2 will average 8 per cent, which implies 43.5 per cent excess air and an excess air loss of 5 per cent. By using proper controls, CO_2 may be raised to 10 per cent, excess air reduced to 19.5 per cent and excess air loss reduced to 2 per cent. Adding the gain from the reduction of stack temperature from 500 deg. to 470 deg., the reduction in fuel loss due to using good controls will be 4 per cent, or for a 200-hp. boiler working 25 days a month, the saving in gas will be 156,000 cu. ft. per month.

E. P. Kramer pointed out the advantages of gas as a steam making fuel in reduction of smoke, flexible control of fire, convenience and economy. Also that comparison of transmission of energy by means of gas mains showed, in a case in California, that the cost of gas transmission was about half that for electricity.

Electron Tube Questions

REFERRING TO the series of articles on electron tubes appearing in these issues I would like further information in regard to some of the points discussed. In Part 3 on page 231 of the April issue it is stated, "Electrons are continually being emitted but as many fall back into the cathode as are emitted, etc." Does this mean that when or before the filament has cooled off that all the electrons emitted that have not gone into the external circuit return to the cathode, none remaining in the space between anode and cathode?

In part 4 on page 286 of the May issue the fact is stressed that the plate current is not an alternating current but that it is an alternating current superimposed upon a direct current: Just exactly what does this mean and how is it done?

Millers Falls, Mass. W. H. M.

A. Referring to your first question regarding the emission of electrons from the cathode, your conception of the action is essentially correct. After the cathode cools, none of the emitted electrons remain in the space between the anode and cathode for any appreciable length of time. All of them are either drawn to the plate or returned to the cathode. If, as

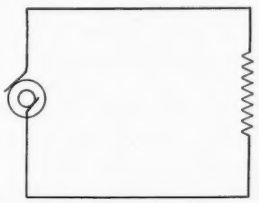


Fig. 1

the cathode cools, the plate potential is maintained, most of the electrons will be drawn to the plate since that is at a high positive potential with respect to the charges on the electrons.

On the other hand, if the plate potential is cut off before the cathode starts to cool, then as the cathode cools most of the electrons fall back into the cathode because of the deficiency of electrons existing there. As explained in the article, if the electrons are liberated from the cathode surface by virtue of the thermal energy, the cathode suffers a loss of negative charges and this manifests itself as a positive charge on the cathode surface. When the tube is operating and there is a high positive potential on the plate, this slight

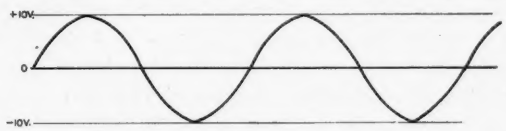


Fig. 2

positive charge on the cathode is, of course, entirely overcome by the higher positive charge on the plate and the electrons accordingly are drawn to the plate.

In the absence of plate potential, however, the positive charge on the cathode does exert an effect and it draws all of the electrons back into it.

Your second question is a little more involved but we believe we can answer it by means of a few diagrams.

The superimposing of an alternating current upon a direct current is quite simple and usually consists of nothing more than connecting a source of direct potential in series with a source of alternating potential.

Consider a circuit containing a small altimeter and a low resistance such as is shown in Fig. 1, for example. The voltage in this circuit would look something like the wave depicted in Fig. 2. Assuming a peak voltage of 10 volts, as indicated, the voltage rises from zero to 10 volts, positive, then falls back to zero, reverses, rises to 10 volts negative and then drops back to zero during each complete cycle. This represents a simple alternating current wave.

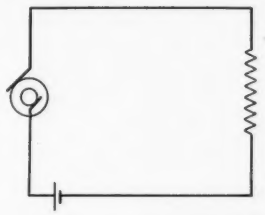


Fig. 3

Now, suppose that a 15 volt battery is connected in the circuit as shown in Fig. 3. The battery supplies a constant potenial of 15 volts regardless of what other sources of potential may be connected in the circuit. In Fig. 4, this 15 volt potential is represented by the straight line drawn above the alternating potential wave.

At the time T_1, the alternating current generator voltage is zero, hence the only voltage acting in the circuit at this time is the battery voltage, namely 15 volts positive. At the time T_2, 90 degrees later in the cycle, the generator voltage is 10 volts, positive. The battery, however, is also contributing 15 volts positive and since the two voltages are in the same direc-

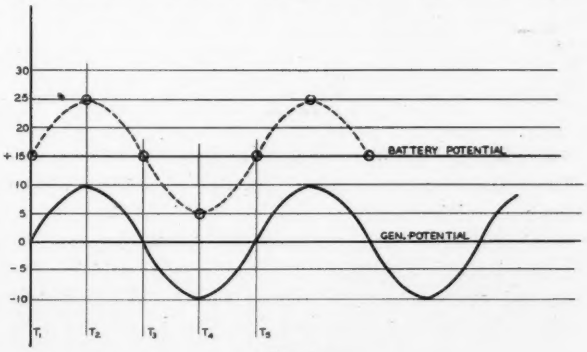


Fig. 4

tion, the voltages are added. The sum, therefore, is 10 plus 15 or 25 volts, which is the effective voltage acting in the circuit at that instant.

At the time T_3, the generator has again dropped to zero, but the battery voltage remains as before, so there is a voltage of 15 volts positive acting in the circuit. At the time T_4, the generator voltage has reversed and is now 10 volts negative. The battery voltage is still 15 volts positive, so the effective voltage acting in the circuit is the difference between these two, or 5 volts positive.

At the time T_5 the generator voltage has again dropped to zero and the battery voltage again is the only voltage acting in the circuit. In this way a direct potential and an alternating potential can be added

By connecting the small circles which represent the sums of the two voltages on the diagrams, it will be seen that another sine wave is traced at a point above that of the original sine wave representing the alternating potential. This wave has exactly the same shape but the voltage is always positive—that is, it does not reverse. In this it is quite different from the alternating potential which passes through zero and reverses in each cycle.

The curve shown by the dotted line represents an alternating potential superimposed upon the 15-volt plate potential delivered by the battery. In the vacuum tube circuit the direct potential is, of course, supplied by the plate battery but the principle is exactly the same and if you understand the idea as presented here, you should not have any difficulty in understanding the same principle as it is applied in electron tube circuits.

Oil Burners for Power Boilers

REFERRING to the communication of Mark Bell in the November issue, in which he disagrees with some of the statements in my articles on oil burners for power boilers, Mr. Bell seems to be of the opinion that I am prejudiced in favor of steam atomizing burners. This is not the case, but I tried to discuss the different types without prejudice, which is always a difficult task, and perhaps I was not entirely successful.

I am of course aware that the changing of tips is an easy job, and under most circumstances no trouble from blocking should occur, if proper care is taken. I do, however, know of at least one case, where owing to the fact that the load varied greatly, and sometimes it was necessary to carry a very light load for considerable periods, it was impossible to get a tip for the mechanical burner with a sufficiently small orifice, which would not give trouble through blocking. The manufacturer, one of the best known in the country, admitted the reality of the difficulty. No trouble should have occurred with handling this load with a steam atomizing burner.

As a matter of fact, one of the leading makers of mechanical burners has patented a type which, it is claimed, overcomes to a large extent the admitted difficulty with most mechanical burners, i. e., that they will not operate to good advantage over a wide range of load.

Of course, on large boilers, where several burners can be installed, we are in a better position to take care of a wide operating range, but this adds to the cost of the installation, and unfortunately, cost is often the deciding factor when an installation is to be sold. You have to be a good salesman to convince the average prospect that he ought to install more burners than are absolutely necessary.

I think that Mr. Bell might come nearer to the truth if he would modify his statement slightly, and say that all marine engineers are in favor of the mechanical type of burner, the reason no doubt being that in this service it is advisable to conserve the water of condensation, but whatever the reason may be, it has become the custom to assume that this is the only type of burner suited to this service, and perhaps it is.

All that is required to start a steam atomizing burner, when there is no steam on the boilers, is a motor driven air compressor. Often there is one for general use in the plant, or if necessary, one of the required capacity can be installed at small cost. An electric oil heater is generally provided, no matter which type of burner is used, moreover, if heavy oil is cold in the tank, it is not so easy to start even a mechanical burner, and sometimes a light oil supply is provided for this purpose.

In my articles, I tried to call attention to those points which should be given consideration when designing an installation. Extra strong pipe is of course obligatory with high pressure mechanical systems, whereas it is not with low pressure systems. This, as Mr. Bell states, is not a great matter, unless you should happen to forget it when installing a high pressure system, in which case you may find yourself in considerable trouble with the inspectors.

Heavy fittings are desirable for any installation.

I do not understand how Mr. Bell received the impression that I think that it costs more to operate a mechanical burner than a steam atomizer. As I stated, it does cost a little more to heat the oil to the higher temperature required for mechanical atomization. This of course would be a very small matter, were it not for the fact that exhaust steam is seldom used for oil heating on mechanical burner installations, though as a matter of fact, it is generally quite simple to get most of the heat from exhaust steam by using two heaters, and taking only the upper range of the temperature curve on live steam.

I stated that with good operation, a steam atomizing burner should not take more than two per cent of the steam generated. Mr. Bell disagrees with this, but I feel sure that with a properly designed system, properly operated, this figure can be maintained, assuming that we are pumping against 10 or 15 lb. pressure and the exhaust steam is used for heating the oil. On the other hand, I am quite willing to agree that some installations are "steam hogs" often more on account of poor operation than poor design.

A very simple calculation will, of course, indicate the steam required for pumping oil under pressure to the mechanical burner, which should be less than half that required for the steam atomizer, and there is no reason why the calculated efficiency should not be maintained in everyday operation. This is, of course, an important factor in favor of the mechanical burner.

Perhaps it is unfortunate that so few designers of steam atomizing burners have given adequate consideration to the fact that the burner is an engine, or energy converter, though in a few quarters consideration has been given to this, and it would appear that a more scientific design of the steam orifice might reduce the steam consumption considerably. There is, I believe, one manufacturer of very large steam atomizing burners who has made considerable advance in this direction.

Bloomfield, N. J. JAMES O. G. GIBBONS.

National Exposition of Power & Mechanical Engineering

Grand Central Palace—New York
Nov. 30—Dec. 5, 1936

	Space Nos.
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Allen Billmyre Corp.	554-555
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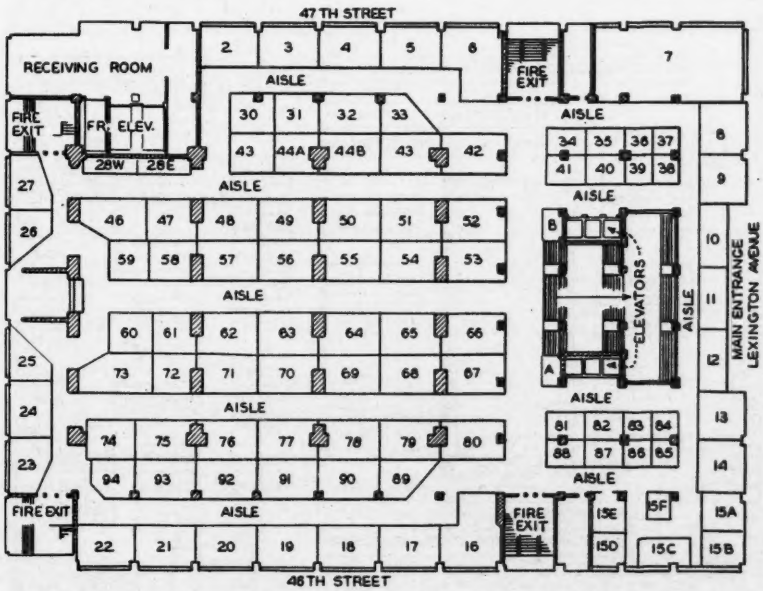

Main Floor

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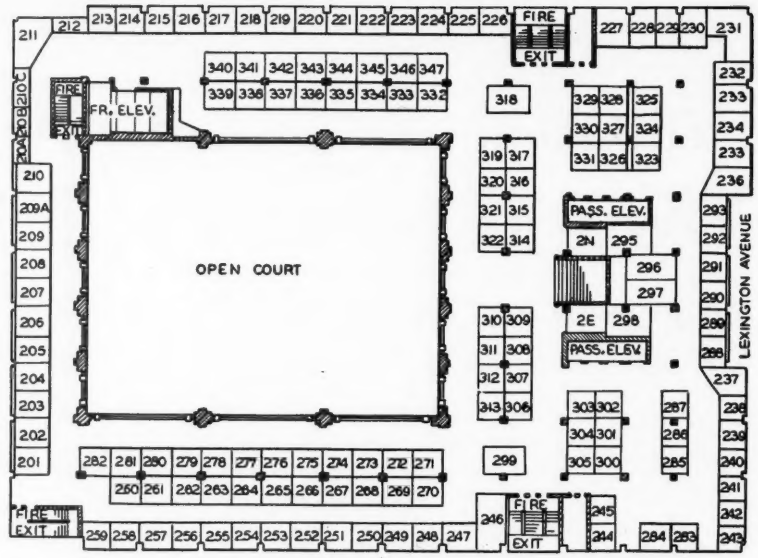

Mezzanine Floor

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Nathan Manufacturing Co. 338-339
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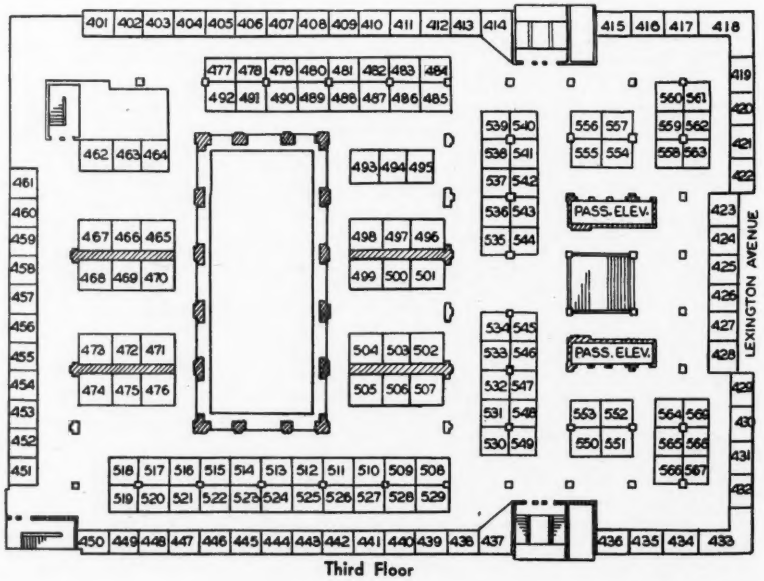

Third Floor

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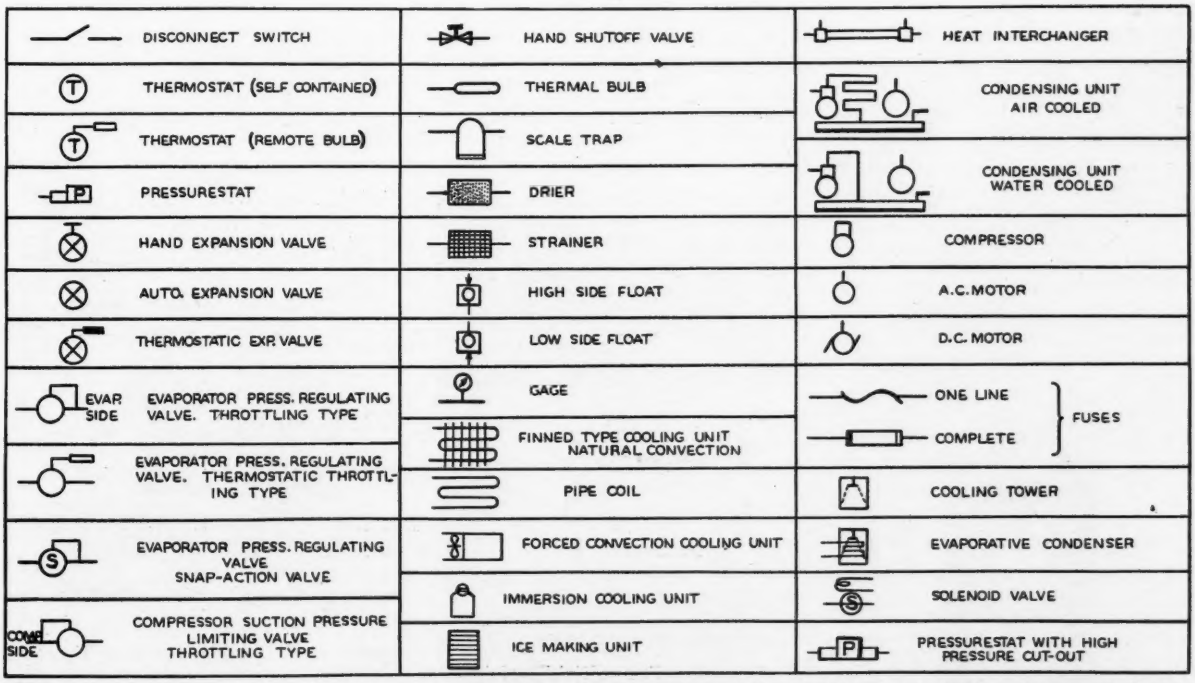
Yale & Towne Mfg. Co.	423 to 428
Yarnall-Waring Co.	66
Youngstown Sheet & Tube Co.	209-209A-210

Standard Refrigeration Society Symbols



Symbols for blue print and general drafting work in connection with refrigeration and air conditioning work that have been standardized by the Refrigeration Division of the National Electric Manufacturers' Association, the Refrigerating Machinery Association and the Air Conditioning Manufacturing Association. The list is not complete nor final but the standardization is a step in the right direction and all the members of the industry will find it of practical use and value.

New Equipment

Commutator Slotter

THE IDEAL COMMUTATOR DRESSER CO., 1033 Park Avenue, Sycamore, Illinois, announces a new slotter in which they have made considerable improvement of design over their previous tool of this type. The new device retains the feature of a swiveled joint for ease of handling with bit at any angle. Major improvements are made in the head, the bit, the stem and the handle.

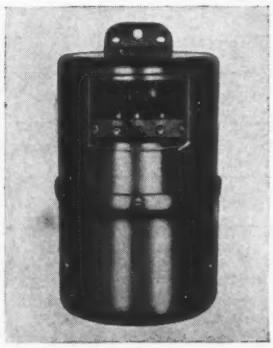
The swiveled head is now made circular in form, the opposite faces having interlocking notches, which enable the user, simply by tightening a screw, to lock the bit at precisely the angle desired and keep it as rigid as though integral with the head.

One end of the tool bit is hardened and sharpened for "V" cutting and the other for "U" slots. Besides cleaning slots in commutators and beveling the sharp edge of the copper after undercutting, it is very handy for removing fins of mica after undercutting and for smoothing burrs on copper segments.

Transformers for Mercury Lighting

TRANSFORMERS and reactors designed especially for the requirements of high intensity mercury lighting have been announced by the Westinghouse Electric and Mfg. Co. Because of the difference between initial starting voltage required for the lamp and the final operating voltage, a transformer with high internal reactance or a reactor must be used with each lamp. This equipment is designed to regulate the current during starting period and to limit the current for slight changes in line voltage during normal operation.

All units are available in two types of mounting — Suspension Mounting Type, from which lighting fixture can be hung, or Wall Mounting Type, which can be mounted on wall or ceiling or any flat surface.



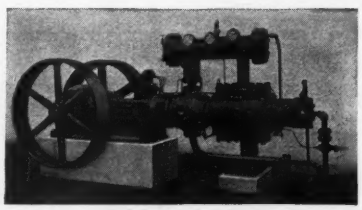
On the Suspension Type Units, the upper half of the case has attached to it a ¾-in. Pipe Nipple through which two line leads, six inches long, project. A convenient form of conduit box should be attached to the ¾-in. nipple for suspending the unit and facilitate making line connections. If it is not convenient to suspend unit directly from conduit box a window with cover is provided in the upper half of case of Reactor-Capacitor, Transformer-Capacitor, and Transformer units to permit pulling leads into upper part of case for making line connections. On Reactor Units only, the lower part of case can be dropped to permit such connections.

The lower half of the case of Suspension Type Units is also provided with a ½-in. Pipe Nipple for suspension of the lighting fixture. The lower half of the case is also provided with a window with cover for access to the terminal board with the various line tap connectors and to permit lamp connections. Proper line tap connection is simply made by attaching lead with stud to proper spring snap terminal, eliminating soldered and taped joint. The change from one primary tap to another is accomplished in a few seconds' time without the aid of tools. All line lamp leads are equipped with solderless connectors to simplify installations.

The Wall Mounting Type of unit is of the same general construction as the suspension type except that mounting lugs for side mounting are welded to side of case and suspension nipples are omitted.

Horizontal Compressors

AN IMPROVED LINE of single horizontal three-stage compressors for pressures from 750 to 2,500 lb. is now offered by Worthington Pump & Mach. Corp., Harrison, N. J. These compressors are well suited for higher pressures, since the compression cylinder requires but one packing box, and that subjected only to moderate pressures. The compressor is ideally applicable for high air pressure for any purpose, also for the compression of oxygen, hydro-



gen, helium and other special gases as well as refinery gas or straight natural gas. Double-row tapered-roller bearings, automatic self-oiling frames with oil-tight covers, Worthington Feather and ring plate valves are features of this improved line of compressors. A choice of steam or motor-drive is offered on all sizes.

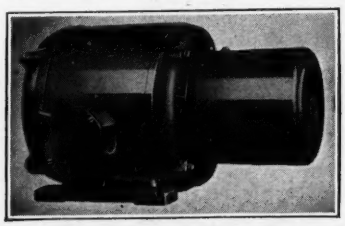
Power Factor Correction Capacitors

THE POWER FACTOR Division of the Cornell-Dubilier Corporation, South Plainfield, N. J., recently announced a change in the design of their box type Power Factor Correction Capacitors.

These new units exceedingly compact, and flexible, are easy to install, lending themselves very readily to various applications. The greatly improved mechanical and electrical features of these units plus their simplicity of installation, make them particularly feasible for modern economical power factor correction and adjustment. It is possible to mount these capacitors on the ceiling, wall or floor in single units or compact groups up to 100 kv-a.

Motor Mounted Brake

TOTALLY ENCLOSED, automatic solenoid brake integral with the motor from fractional up to 10 hp., at 3600 r.p.m. is announced by Cutler-Hammer, Inc., Milwaukee, Wis. This brake can be supplied mounted on any motor from the motor

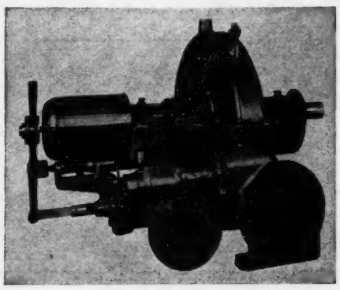


manufacturer, saving time and trouble of mounting and aligning. Among its many features are appearance to harmonize with motor design, dependable performance, ease of adjustment and smooth operation.

The rotating member, a single, heavy, moulded disc, shows little wear on life tests even for maximum horsepower, the enclosing case protecting it from dirt and mechanical injury. The brake is suitable for a.c. or d.c. and is available with dust-tight, weather-proof and water-tight enclosures.

Steam Turbine

FOR DRIVING general purpose machinery in industrial plants and auxiliary equipment in generating stations and on shipboard, a new and improved line of Type "C" turbines is announced by Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa. The turbines are of the impulse type having one



pressure and two velocity stages. They are built in capacities ranging approximately from 5 to 500 hp., at turbine speeds of 1000 to 5000 r.p.m. Suitable for use with steam pressures up to 650 lb. ga. and for total temperatures up to 750 deg. F., they may

be operated either condensing or non-condensing with rotation in either direction. Efficient and reliable, these turbines are particularly adapted to driving pumps, forced and induced draft fans, compressors, Jordans, pulp beaters, pulverizers, line shafts, and similar apparatus; either direct connected or through gear or belt drive.

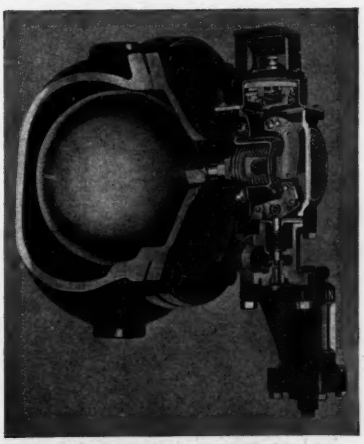
Armstrong Trap

ARMSTRONG MACHINE WORKS, Three Rivers, Mich., announce the No. 312 forged steel trap. This trap uses the Armstrong inverted bucket and free floating lever operating principles and is designed to take care of high pressure drips at pressures

up to 450 lb. gage. At this pressure the trap has a continuous discharge capacity of approximately 2500 lb. of condensate per hour. There are only two moving parts—the bucket and the valve lever assembly. The complete interior mechanism is of stainless steel. The trap weighs about 30 lb.

Boiler Water Control

MCDONNELL & MILLER, Wrigley Bldg., Chicago, Ill., offer the patented, cool feed valve, combination automatic boiler water feeder, and low water cut-off for low pressure heating boilers. This unit can be used on boilers where the maximum steam pressure runs as high as 75 lb. the



only requirement being that the available water pressure be at least 10 lb. higher than the maximum steam pressure. The unit is easily installed complete on any type boiler. On the hand fired low pressure steam boiler it offers a convenience and protection while on the automatically fired low pressure steam boiler, it makes the control of the boiler 100 per cent automatic.

Belt Lacing

TEK-LACE, a new non-metallic belt lacing, gives the safety, efficiency and durability of endless belting, plus the convenience, low cost and ease of application of ordinary belt fastenings. It is used for fastening flat belts or V-belts. Made of strong fibres, Tek-Lace is only 0.055 in. in diam., but has a tensile strength of 100 lb. This is more than 50 per cent stronger than Federal specifications for raw-hide ¼ in. wide and ⅛ in. thick. A 3-in. belt fastened with Tek-Lace has a tensile strength of 2000 lb. at the joint. The small holes that it requires are pierced through the belting without cutting the fibres and weakening the belt. Tek-Lace sets into the belt instead of standing out above the surface. The joint is thus as smooth and flexible as any other part of the belting. Fastening may be made by means of an ordinary awl or other piercing tool. For quick application, however, a special piercing tool with gauge and channeling device is available. Sufficient Tek-Lace for lacing 15 three-inch belts sells for $1.50 per box. The piercing tool is priced at $2.50. It is distributed exclusively by Sudbury Laboratory, P. O. Box 941, South Sudbury, Mass.

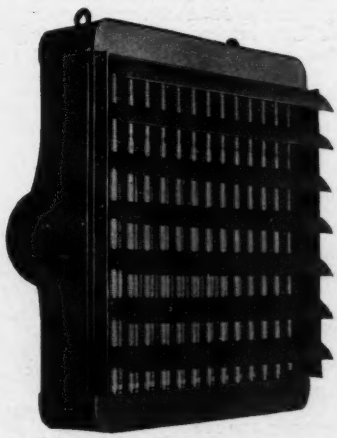
Allpax Gasket Cutter

TO MAKE the cutting of gaskets accurate, quick and easy, the Allpax Co., Inc., Mamaroneck, N. Y., has recently placed on the market a new device for this purpose which is applicable to such gasket materials as asbestos sheet, rubber sheet, cloth inserted sheet, felt and cork.

Six double edge cutting blades go with the cutter, these being made of specially tempered steel and are adjustable for any thickness from 1/100 to ⅝ in., and any diameter from 1 to 36 in. With the cutter is furnished a cutting board 18 by 18 in. made from built-up plywood.

Ilg Unit Heaters

FOLLOWING the popular demand for smart modern colorful finishes, the Ilg Electric Ventilating Co., 2850 N. Crawford Ave., Chicago, Ill., has now made the Ilg unit heater available in a series of special Deluxe color finishes. It is believed that this is the first instance in unit heater history where a wide range of color finishes has been made a catalogued feature of the line.

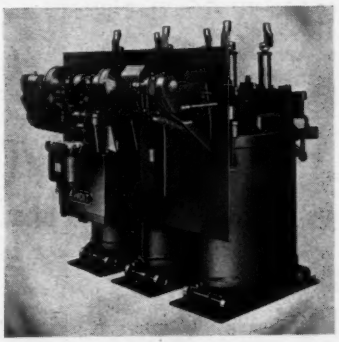


It is expected that these colors, which include Spanish ivory, heather brown, silver, pacific blue, etc., will prove of particular interest for use in offices, stores, restaurants, where the proper color can now be selected to harmonize with the furnishings of the room.

The finish is a special baked crackle, which has a rich appearance, is enduring and in every way makes the unit heater an asset to the appearance of the room.

Indoor Oil Circuit Breaker

A NEW INDOOR STATION type oil circuit breaker, type FZ-210, has been announced by Condit Electrical Manufacturing Corp., Boston, Mass. It is equipped with inter-



rupting devices called Ruptors, which it is claimed give quick clearing of short circuits along with low arc energy, low pressure and a minimum of oil deterioration. Other features claimed for this equipment are: enclosed low inertia, high speed mechanisms; internal oil-type shock absorbers; silvered contacts; oil and gas separators; and Bakelain bushings.

It is furnished for 600, 1200 and 2000 amp. at 15 kv. Interrupting rating 250,000 kv-a. It is arranged for cell mounting (truck or platen) or for mounting on framework.

Air Filter

STAYNEW FILTER CORP., Rochester, N. Y., announce the development of a new automatic impingement type filter. The operating principle of this filter is somewhat different from those already in use. Two revolving curtains give a four-stage filtration. Dust collected on the intake side is removed by passing through the oil bath before the curtain which had been carrying the dust returns to the outlet side. Any oil entrainment from the first curtain moistens the second curtain, which does not pass through the oil bath. The second curtain prevents oil entrainment. Being slightly moist, it arrests any of the finer particles that may remain in the air stream.

Voltmeters and Ammeters

A NEW LINE of Round Chart Recording Voltmeters and Ammeters is announced by The Bristol Company. These new instruments have been developed to take care of the requirements of electric utilities for accurate, rugged instruments that are easy to use and service. They also are intended to fill the requirements of industrial plants, especially for process work where voltage and current affect

the quality and cost of manufacture of the product. They are offered in models for wall, switchboard, flush panel, and pole mounting, and for portable use.

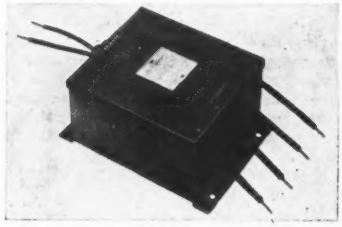
These instruments are housed in a very practical moisture-, fume-, and dust-proof case made of an aluminum alloy. The measuring element is a separate unit that can be easily replaced by removing only three screws from the mounting. The pen-arm is inverted and is pivoted at the top in such a way that the pen pressure against the chart is delicately controlled by gravity. The pen arm is equipped with a convenient micrometer zero adjustment and also a replaceable chromium plated tip, which may be removed by loosening only one screw.

Two-drop, fine bore, platinum point fountain pens, especially developed for these instruments, are used. The pen makes a legible record even when recording values that fluctuate widely.

These new electric recorders are offered with spring-driven and electric Telechron clocks.

Signaling Transformer

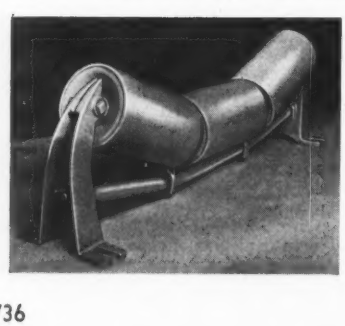
WESTINGHOUSE SIGNALING TYPE transformers are for general application where a low voltage power supply is required such as for the operation of alternating-current bells, gongs, horns, sirens, annunciators and signaling systems. They are designed in a suitable number of volt-ampere capacities and with a wide range of secondary voltage taps to take care of the requirements of most installations.



The volt-ampere capacity of these transformers is based on the full secondary rating, 24 v. Reduced voltage taps are rated to deliver power at the lower voltage in proportion to the full secondary voltage. Thus the 100-volt-ampere transformer will deliver full power at 24 v., but when using the 16-v. taps, the rating is reduced to approximately 67 volt-amp., and for the 12-v. tap to about 50 volt-amp. These transformers are designed to be connected to the power line continuously with very low power loss.

Belt Conveyor Carrier

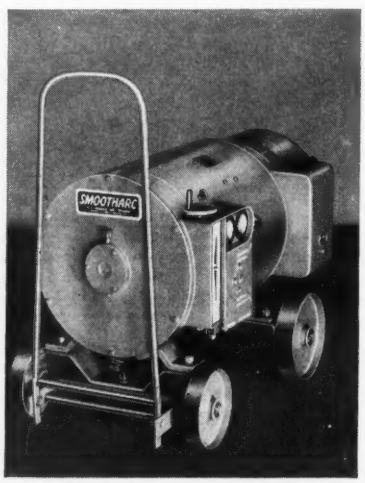
OUTSTANDING features of a new belt conveyor carrier recently announced by Stephens-Adamson Mfg. Co. of Aurora, Ill., include a "truss-frame," sealed ball bearings, light weight, strong and comparatively inexpensive. This carrier is of the 3-roll in line design with outer rollers inclined to give the belt a 20 deg. trough. The whole roller assembly is tilted to center the belt without guide rollers and particular effort has been made to produce a carrier that would minimize wear and tear on the conveyor belt. All parts are made of steel and malleable iron. The rollers are built of 5-in. diameter steel tubing with ends smoothly rounded over the pressed steel end plates to prevent any tendency to fray the belt. Roller ends are recessed to house the bearings and allow rollers to be closely spaced to eliminate danger of pinching belts.



Renewable, cartridge type ball-bearings are used throughout. Each bearing is packed with grease and sealed at the factory and should be good for several years of operation before attention is necessary. The load is carried by a tension rod instead of depending upon the stiffness of a heavy cross member for support. It is built in sizes for belts 18 to 48 in. wide.

Smootharc Welder

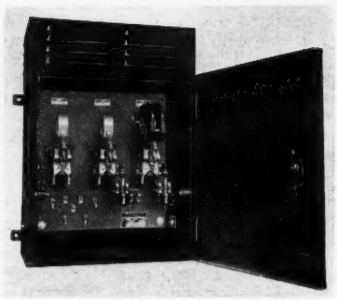
HARNISCHFEGER CORP., Milwaukee, Wisc., announces new Smootharc Welders with single current control, self excitation and internal stabilization in vertical styles for 75, 100 and 150 amperes and in horizontal mounting for 200, 300, 400 and 600 amperes. Current control uses shifting generator brushes with micrometer screw adjustment actuated by a control dial. Excitation is from auxiliary brushes on the main commutator, these brushes shifting to give proper excitation for each current setting. Interpole windings extended to the main pole shoes give regular interpole effect, also stabilization. All steel parts are annealed to give best magnetic quality. Instruments are mounted on the control panel at the side of the motor housing.



Motor Starter

FOR PROVIDING a universal, compact, standardized unit suitable for use with a wide range of motor sizes and requiring only reconnection of the self-contained resistors to give proper resistor values, The Electric Controller & Mfg. Co., 2683 E. 79th St., Cleveland, Ohio, announce their new Type RD direct current mill type starter.

These starters employ the new type RD mercury acceleration relays which permit



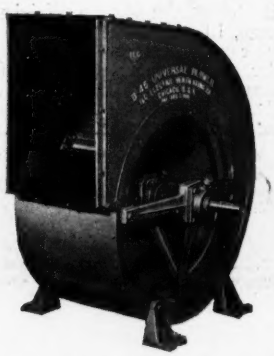
a time range of ½ sec. to 2 sec. per step. They are quickly adjustable for this time range by means of a very accessible thumb screw and lock nut arrangement.

A 3-coil, unbreakable resistor is mounted on the top of the starter cabinet and is covered by a ventilated enclosure. Particular attention has been given to the design of these resistors so that by only changing the manner in which they are connected, these starters can be used with any motor within the range of 5 to 25 hp., 230 v.

Blower Drive

KNOWN as the floated drive bracket, a new sound and vibration damping device for direct connected blowers is announced by the Ilg Electric Ventilating Co., 2850 N. Crawford Ave., Chicago, Ill. It is intended for use where extraordinary precautions must be taken to maintain quiet operation.

The standard Ilg motor bracket is mounted on a second floating bracket



which is insulated from the blower housing to which it is secured by flexible rubber cushions. There is no metal to metal contact between this floated drive bracket and the blower housing.

Four point vertical floating of the weight takes complete advantage of all three loading factors—compression, tension and sheer—producing the utmost dampening effect.

The new Ilg floated drive can be obtained as original equipment on any Ilg type B or type BC direct-connected Universal blower, or, the floated drive bracket can be mounted on any of these blowers already in the service.

N. A. P. R. E. Election

WITH A WELL rounded program, an enthusiastic attendance of 500 and a well arranged equipment exhibition, the twenty-seventh annual convention of the National Association of Practical Refrigerating Engineers, held at the Drake Hotel in Chicago, November 11 to 13,

was acclaimed a huge success. At the final session Pittsburgh, Pa., received favorable consideration as the 1937 convention city and the following officers were elected: President, Louis P. Mantz, Pittsburgh, Pa.; First Vice-President, Chas. A. Conley, Memphis, Tenn.; Second Vice-President, C. W. Gilmore, Chicago, Ill.; Secretary, Emerson Brandt, Chicago, Ill.; Treasurer, E. T. Quinn, Los Angeles, Cal.; Sergeant-at-Arms, Howard H. Peterson, Yakima, Wash.; Board of Directors, K. M. Holiday, Springfield, Ill., H. T. Holbrook, San Francisco, Cal., Wm. H. Motz, Chicago, Ill.; Chairman Educational Board, Edwin S. Libby, Chicago, Ill.; Chairman Membership Committee, Charles J. Chase, New York, N. Y.

C. J. Fechheimer Joins Louis Allis Co.

C. J. FECHHEIMER has recently joined the engineering staff of The Louis Allis Co., Milwaukee, manufacturers of electric motors, in the capacity of consulting engineer. For over 20 yr. Mr. Fechheimer has been very closely associated with the electrical manufacturing industry, as designing engineer, and as research engineer.

As author and lecturer on both electrical and mechanical subjects—as well as an inventor—he has personally contributed substantially to the advancement of the electrical industry. His work on self-starting synchronous motors and on heat problems in electrical apparatus are among his well-known contributions. For the past 5 yr. Mr. Fechheimer has been engaged as a consultant in private practice, and recently was appointed director of the College at the Milwaukee School of Engineering.

Bucher Elected Executive Vice President of Westinghouse

AT A MEETING of the Board of Directors of the Westinghouse Electric and Mfg. Co., George H. Bucher was elected Executive Vice President of the Company with headquarters at Pittsburgh, Pa. Mr. Bucher is also President and General Manager of the Westinghouse Electric International Co.

Mr. Bucher has been connected with the Westinghouse organization since September 1, 1909. After graduating from Pratt Institute, Brooklyn, in both steam and machine design and also electrical engineering, Mr. Bucher joined the Westinghouse Electric and Manufacturing Company at East Pittsburgh as a graduate student. In 1911 he was transferred to the Export Department in New York.

In 1920, he was appointed Assistant to General Manager of the Westinghouse Electric International Company, and a year later, 1921, he was made Assistant General Manager, which position he held until 1932, when he was elected Vice President and General Manager. In 1934 he was elected President and General Manager of the same Company, and in 1935 he was elected Vice President of the Westinghouse Electric and Manufacturing Company.

Mr. Bucher is a member of the A.I.E.E., the Engineers Club, National Foreign Trade Council and India House.

Engineering Foundation Elects Officers

ELECTION of Frank Malcolm Farmer, vice president and chief engineer of the Electrical Testing Laboratories, New York, as chairman of the Engineering Foundation, research organization of the national engineering societies, is announced. Mr. Farmer, an authority on electrical measurements, electrical insulating materials, testing of engineering materials, and high voltage cables, succeeds H. P. Charlesworth, assistant chief engineer of the American Telephone and Telegraph Co.

D. Robert Yarnall of the Yarnall-Waring Co., Philadelphia, was re-elected vice chairman of the Foundation. Dr. Alfred D. Flinn continues as director and secretary. Elected to the executive committee were Otis E. Hovey of 71 Broadway, New York; A. L. J. Queneau, metallurgist of the United States Steel Corporation, New York; and Prof. Walter I. Slichter of Columbia University.

Mr. Yarnall was chosen chairman of the Foundation's research procedure committee, other members of which were named as follows: Frederick M. Becket, vice president of the Electrometallurgical Company, New York; Thaddeus Merriman of 380 Riverside Drive, New York, representing the American Society of Civil Engineers; Walter H. Fulweiler of Wallingford, Pa., representing the American Society of Mechanical Engineers; Lewis W. Chubb, director of the Westinghouse Research Laboratories, East Pittsburgh, Pa., representing the American Institute of Electrical Engineers; Sam Tour of 47 Fulton Street, New York, representing the American Institute of Mining and Metallurgical Engineers; Alfred D. Flinn, secretary.

The Foundation's Iron Alloys Committee, which is directing a critical review of the world's knowledge of steel, alloy steel, alloy iron, cast, wrought, and pure iron, will be composed of: Prof. George B. Waterhouse of Massachusetts Institute of Technology, chairman; Dr. J. G. Thompson, chief of the section on chemical metallurgy, National Bureau of Standards, representing Lyman J. Briggs, director of the Bureau; John W. Finch, director, and Reginald S. Dean, chief engineer, of the metallurgical division, U. S. Bureau of Mines; James T. MacKenzie, metallurgist and chief chemist of the American Cast Iron Pipe Co., Birmingham, Ala.; Dr. John Johnston, director of research of the U. S. Steel Corp., Kearny, N. J.; Dean Bradley Stoughton of Lehigh University; Jerome Strauss, vice president of the Vanadium Corp. of America, Bridgeville, Pa.; Thomas H. Wickenden, metallurgical engineer of the International Nickel Co., New York; James H. Critchett, vice president of Union Carbide and Carbon Research Laboratories, New York; Wilfred Sykes, director of the Inland Steel Co., Chicago; Frank T. Sisco of New York, editor.

The Welding Research Committee, sponsoring investigations in university and industrial laboratories, and compiling a survey of the welding practice and theory of all nations, will include: Dr. Comfort A. Adams, director of the American Bureau of Welding, chairman; David S. Jacobus of the Babcock & Wilcox Co., New York; Henry M. Hobart of the General Electric Co., Schenectady; Mr. Critchett; Frederick T. Llewellyn of the U. S. Steel Corp., New York; Colonel Glen F. Jenks, commanding officer of the Watertown (Mass.) Arsenal; John J Crowe of the Air Reduction Sales Co., Jersey City, N. J.; C. L. Eksergian of the Budd Wheel Co., Detroit; William Spraragen of New York, secretary.

Additional members of the committee will be designated to represent the railroad, public utility, non-ferrous metals, automotive and aircraft, shipbuilding, and oil industries, and electric welding apparatus manufacturers, resistance welding manufacturers, machinery manufacturers, and structural steel fabricators.

A. S. R. E. Meeting

RECORD REGISTRATION is expected at the 32nd Annual Meeting of The American Society of Refrigerating Engineers, which opens Wednesday morning, December 2, for a 3 da. session at the Hotel Pennsylvania in New York City. Attendance at this event last year was the best since 1930, and improved business conditions indicate a record crowd this time. All meetings, except the joint meeting with the A. S. M. E. on the morning of December 3, will be held in the Salle Moderne on the roof of the Hotel Pennsylvania. A diverting program of entertainment has also been arranged for members and their guests and for women attending the convention. The complete program of technical sessions follows:

Residence Cooling Investigations, by Professor H. J. Macintire, University of Illinois, Urbana, Ill.

A Review of Refrigeration and Air Conditioning Codes and Standards, Chester Lichtenberg, General Electric Co., Fort Wayne, Ind.

Evaporative Cooling for Comfort, W. L. Fleisher, Consulting Engineer, New York, N. Y.

Moisture in Relation to Insulated Walls, Harvey B. Lindsay, President, Dry-Zero Corp., Chicago, Ill.

A Study of Heat Transfer in Unit Refrigerant Condensers Which Use Evaporative Cooling, Byron E. James, York Ice Mach. Corp., York, Penna.

Air Conditioning Applied to Lithography, L. C. Weber, Bureau of Standards, Washington, D. C.

Report of Joint Committee—Glenn Muffly.

Informal Talk on Air Conditioning, L. R. Boulware, Carrier Corp.

Method of Computing Thermal Properties of Oxygen and Nitrogen, W. F. DeBaufree.

Review of Psychrometric Theory and Data, W. H. Carrier, Chairman of the Board, Carrier Corp., Newark, N. J.

Brine Solutions in Truck Bodies, O. S. McGuffey, Lansing, Mich.

Beer Dispensing Methods, John Wyllie, Temprite Co., Detroit, Mich.

Freon 12 Thermal Expansion Valve Requirements, J. C. Bergdoll, Product Engineer, York Ice Mach. Corp., York, Penna.

Informal Talk on Frozen Foods, Gardner Poole, Frosted Foods, Inc.

Silica Gel in Air Conditioning, W. E. Stark, Bryant Heater Co., Cleveland, O.

Commercial Absorption System, Glenn F. Zellhoefer, Williams Oil-O-Matic Heating Corp., Bloomington, Ill.

Problems in Household Absorption System, Dr. W. R. Hainsworth, Vice President, Servel Corporation, New York, N. Y.

The Open Absorption System, Dr. A. A. Berestneff, Carrier Corp., Newark, N. J.

Officers of the A. S. R. E. this season are Louis S. Morse, president; H. M. Williams, vice president; Crosby Field, vice president; C. T. Baker, treasurer; David L. Fiske, secretary.

Organizing an Industry from Within

MANY INDUSTRIES have, from time to time, tried to set up an organization to aid in regulating production and distribution for the benefit of the industry and to do away with damaging competitive practices. Difficulties have been encountered because of the anti-trust laws, which ban the limitation of competition and because of failure to arrange a plan that would ensure the adherence of participants when the going became difficult. In the coal industry, government, because of the importance to the country of maintenance of a solvent and effective source of fuel supply, has tried to take a hand in setting up and enforcing rules for the conduct of production and distribution, but these have run afoul of obstacles that so far have rendered them ineffective.

Meanwhile, in one field a plan has been in operation for a considerable period to maintain competitive selling, yet guard the industry against ruinous price cutting and to ensure to consumers a stable and dependable source of supply. It is in the nature of a sellers' coöperative to maintain quality of product, endeavor to give each customer the fuel best fitted to his needs and to take care of the output of participants, yet maintain competition among participants as to service to consumers in regard to price and delivery.

Appalachian Coals, Inc., which was organized in 1932, is a corporation whose stock is owned by participating producers and acts as selling agent for them, yet provision is made for the use of subagents or, in case all of a producer's output is not sold, for direct selling by the producer. The producing area involved is West Virginia and eastern Kentucky mines, divided into 8 regional groups, each group nominating two directors, with nine directors being named by the stockholders as a whole, the directors serving without compensation.

Active management is in the hands of officers chosen by the directors and a selling staff organized by the officers.

While the corporation is not expected to engage in production, its charter permits it to do so and gives it the usual powers necessary to the conduct of a producing and marketing organization. Price fixing is not an object, in fact the agreement between producers and the corporation gives the latter power to advance or reduce prices to keep them competitive as between participating producers and to meet competition of producers not participating in the organization. Participants acquire common stock, which has all the voting power, in proportion to outputs of coal; also preferred stock, which is sold to provide working capital, has no voting power and is redeemable by the corporation as the directors may determine. Any participant may withdraw at the end of any year after 1937 by giving 60 days' notice and his common stock must then be offered for redemption by the corporation, or the directors may authorize sale of the stock to any other stockholder.

Advantages to producers, as stated in the prospectus, are establishing a larger market in which all participants can share, to give producers more uniform operating time, better advertising of product, prevention of dumping and of serious credit losses, protecting the quality of output while reducing the cost of selling, establishing conditions that will permit producers to pay as high wages as competitive conditions permit. Advantages to consumers are, assurance of a fair competitive price, supply of coal best suited to plant needs, reliability of supply and stability of price, fair dealing and adjustment of complaints.

It would seem that organization from within of any industry with the objects as set forth, and operated by those most vitally interested in the welfare of the industry should be advantageous to the industry, to its workers, to its customers and to the public at large.

News from the Field

JULIAN M. AVERY, electro-chemical and metallurgical engineer, formerly with Union Carbide and Carbon Corp., has joined the staff of Arthur D. Little, Inc., research chemists and engineers of Cambridge, Massachusetts. Mr. Avery is a graduate of Massachusetts Institute of Technology, class of 1918, and obtained his first practical plant experience as a Lieutenant in the Chemical Warfare Service. Since then he has had a wealth of experience in practical plant operation, research developments, patent work and the investigation and evaluation of inventions and processes, acquired both in the United States and in Europe while serving various subsidiaries of Union Carbide and Carbon Corporation.

DUE TO RAPID GROWTH of residential and commercial load, the San Diego Consolidated Gas & Electric Co. announce the purchase of new generating and boiler equipment to be installed in its Station B at San Diego, Cal. The generator will have a normal rating of 35,000 kw. and overload capacity of 43,750 kw. It is 25 per cent larger than the company's largest present generator. Two new boilers with a rating of 200,000 lb. per hr. each will be installed and will increase the steaming capacity of the station by about 60 per cent.

LEON JOHN WILLIEN, operating gas engineer, Public Utility Eng. & Service Corp., formerly Byllesby Eng. & Mgt. Corp., was awarded the Charles A. Munroe Award at the Annual Convention of the American Gas Association at Atlantic City, N. J., in recognition of his outstanding contribution in the general interest of the gas industry. One of the highest honors bestowed by the Association, the award was made to Mr. Willien for his "rational and consistent research, success and number of applications, generosity of contributions, originality and usefulness to the industry, in the field of advanced processes for manufacturing, mixing and transmitting gas."

SUPERSEDING AN ANNOUNCEMENT of change in name voted on in September, the board of directors of Byllesby Engineering & Management Corp., Chicago, Ill., announce a change of name to Public Utility Engineering & Service Corp. The name previously announced was Public Utility Service Corp., but it was afterwards discovered that this name was not available.

The purpose of the change in name is to more clearly indicate existence of the latter corporation as a separate and distinct organization from H. M. Byllesby & Co., the investment banking house.

Byllesby Eng. & Mgt. Corp. was organized in 1919 to render engineering and managerial services to public utility and other companies particularly comprising the Standard Gas & Electric Co. system. In September, 1935, the stock of the management corporation was sold without profit to these companies by Standard Gas & Electric Co. and the corporation is functioning as a service organization on a cost basis to the companies acquiring it.

CORNING GLASS WORKS, Corning, N. Y., recently announced that Leslie W. W. Morrow, for the past ten years Editor of Electrical World, has been appointed General Manager of the Company's new Fibre Products Division. Mr. Morrow has resigned from the McGraw-Hill Co. and has assumed the duties of his new assignment. He will be located at Corning, New York. The Fibre Products Division, an important new division of the Corning Glass Works, has been in operation only since May of the present year. Already fibrous glass is widely used as a heat insulator for building, ships, and mechanical refrigerators, but its unusual chemical and physical characteristics suggest infinite applications for both home and industry of the future, and it is extensively used for the woven insulation on electric cable and wire, as the material is impervious to moisture and shows no appreciable deterioration with time.

ANNOUNCEMENT is made by the Harnischfeger Corp. of Milwaukee that Frederick Salditt has been appointed vice-president. Mr. Salditt has been with the Harnischfeger Corp. for over 13 yr., during which time he has worked in every

department of the organization. As export manager, he has traveled extensively in foreign markets representing the entire line of Harnischfeger products. In addition to his duties as vice-president, Mr. Salditt will continue to retain supervision of foreign operations.

A. M. BYERS Co., Pittsburgh, Pa., through M. J. Czarniecki, Vice President in charge of sales, announces the following appointments that were made effective November 2, 1936: George B. Cushing has been promoted to Manager of Sales Promotion. B. D. Landes, who has been in the technical group since its inception, has been appointed Manager of the Engineering Service Department. T. C. Winans has been appointed Advertising Manager. R. H. Gardner, formerly of the Washington office of A. M. Byers Co., has been appointed Manager of Pipe Sales.

PLANT FACILITIES of the Fibre Products Division of the Corning Glass Works will be enlarged. Work of digging the foundations for three new buildings, to have a total area of 46,000 sq. ft. has been started. Six months ago the Fibre Products Division started up production in the new factory which had been built for it in Corning. The three new factory units will stand close to the first and will have walls built of glass. The first of the new plant units will offer increased storage and shipping facilities, the second will provide additional manufacturing space, and the third will accommodate construction of an additional glass melting furnace. Construction of three new buildings, following close upon the opening of the Fibre Products Division, is in response to increasing demand for the new glass commodity.

LEEDS & NORTHRUP Co., 4901 Stenton Ave., Philadelphia, Pa., announce the opening of a new branch office at 804 Judd Bldg., 75 Pearl St., Hartford, Conn.

ANNOUNCEMENT has been made by the Louisville Gas & Electric Co. of the purchase of 25,000 kw. in electric generating equipment, boilers and auxiliaries to be installed in the Canal St. plant in Louisville. The present Canal St. Station has a capacity of 18,500 kw. and Waterside Station 92,500 kw. The new unit will bring the total generating capacity up to 135,000 kw., exclusive of 80,000 kw. in the company's hydroelectric plant at the Falls of the Ohio River near Louisville.

C. F. BOLLES, after 13 yr. experience with the Public Service Electric & Gas Co. of New Jersey in the design and construction of outdoor switching and substations, has joined the New York office of the Delta Star Electric Co. of Chicago, in the capacity of sales engineer.

E. F. FEELY, representative of The International Nickel Co. in South America, and J. S. Vanick, a member of the Development and Research Division, are visiting several South American countries within the next few months to offer consultation service to industrial executives and engineers on problems involved in the production and application of nickel alloys.

TO ENABLE ENGINEERS and operators to achieve the economic balance essential to minimum production costs in refinery and other high temperature operations, The Timken Steel & Tube Co. has developed a new series of high-temperature steels, to be known as Sicromo 1, 2, 3 and 5, which extend the economic possibilities of Timken DM Steel. Sicromo steels contain the 0.50 per cent molybdenum, found to be most effective for increasing creep strength; high silicon content develops oxidation resistance, while economic resistance to corrosion is given by the varying percentages of chromium indicated by the numbers. Sicromo 1, 2 and 3 are suitable for use in high-temperature applications where low to medium oxidation and corrosion resistance is required; Sicromo 5 is designed for severe corrosion and oxidation, with equipment cost the minimum consistent with economic life and efficient operation.

STEEL AND TUBES, INC., a subsidiary of Republic Steel Corp., Cleveland, has announced the following appointments in the sales department: Lee M. Hogan, former Manager of Advertising and Sales Promotion, has been named District Sales Manager of the New York District. Irving Whitehouse, former Assistant Manager, is appointed Manager of Sales Promotion. A. R. Smith, who has been Superintendent of the Elyria division of Steel and Tubes, was promoted to General Manager of that division upon the retirement of A. E. Adams.

PLANS are being made to hold the National Oil Burner and Air Conditioning Exposition and Convention on March 15 to 19, 1937, at Convention Hall of the Commercial Museum, Philadelphia, Pa. This is the third time in 14 yr. that the oil burner industry has chosen Philadelphia as the site of exhibit to the trade and public the newest developments in its field principally because this territory has been one of the world's greatest markets for the home comforts and industrial appliances dealt in by this branch of industry.

ANNOUNCEMENT of the appointment of Robert Jory as sales engineer with headquarters at the New York office is made by Riley Stoker Corp. Mr. Jory has had a broad experience in the design of large boilers both abroad and in the United States, being associated with the following engineering organizations: Stevens & Wood, Inc., Electric Management & Engineering Corporation, American Gas & Electric Company and Sanderson & Porter.

THE BABCOCK & WILCOX TUBE CO., Beaver Falls, Pa., announces the appointment of W. W. Williams as General Manager of the Company, and T. F. Thornton, formerly Sales Manager of the Detroit Office District, as General Sales Manager.

THE BABCOCK & WILCOX CO., announces the appointment of J. S. Allison, Jr., as Chicago District Manager of its Refractories Sales Department, 140 South Dearborn St. He will be assisted by H. J. Shaner and R. M. Onan, who have been handling the sale of refractories in Chicago District for several years. Mr. Allison was formerly associated with Armstrong Cork Products Co.

REPORT of the Engineers' Council for Professional Development on the list of accredited curricula for undergraduate engineering courses and the colleges having such curricula in the New England and North Atlantic states has been issued and is now available from their offices, 29 W. 39th St., New York, N. Y. The report gives the basis for approval of study courses as well as the list of colleges where approved courses are offered.

J. L. BAKER, formerly president of Baker Ice Machine Co. and president of the Omaha Manufacturers' Assn., has been elected president of the Refrigerating Machinery Assn.

PLANS FOR A National Power Conference are announced by Geo. Pfisterer. Headquarters are in La Salle Hotel, Chicago. It is proposed to hold a meeting of the Conference in 1937 and to issue a bulletin on Power Progress. Enrollment fee is $1.00 and correspondence is invited.

DR. C. H. WATSON, of New York, Medical Director of the American Telephone & Telegraph Co., was honored by re-election to the presidency of the National Safety Council, at the Twenty-fifth National Safety Congress held in Atlantic City October 5-9. As head of the National Safety Council since October, 1935, he has approached and handled many difficult administrative problems with calm, practical intelligence that has won the admiration of his fellow officers, his executive committee and members generally. Dr. Watson became interested in safety work at the time of his first association with the New York Telephone Company in 1910. His work gravitated toward surgical lines and the greater part of his hospital time was expended between the Bushwick Hospital and the Eastern District Hospital, located in Brooklyn. Other National Safety Council officers for 1937 are: Vice-Presidents, D. D. Fennell, Chicago, Ill.; Dr. Hart E. Fisher, Chicago, Ill.; John B. Gibson, Chicago, Ill.; Hon. Harold G. Hoffman, Trenton, N. J.; Albert S. Regula, New York City; A. V. Rohweder, Duluth, Minn.; R. T. Solensten, New York City; Albert W. Whitney, New York City; W. E. Worth, Chicago, Ill., and Managing Director W. H. Cameron, Evanston, Ill.

DR. D. S. JACOBUS was presented with the Morehead medal for outstanding advancement of the utilization of calcium carbide or its derivatives. His work in formulation of codes and procedures for fusion—welded pressure vessels—was the basis of the award, presentation being made at the annual meeting of International Acetylene Assn. on Nov. 18th. His work in the field of education and boiler

construction and operation is well known.

REPUBLIC STEEL CORP. has appointed William Hogensen, Jr., as special representative for Toncan iron enameling stock to coördinate the interests of manufacturer, contractor, architect and owner.

P. L. RHODES of Chatham, N. J., president, Rhodes Packing Co., has just been appointed southern sales representative by Homestead Valve Manufacturing Co., Coraopolis, Pa. Many supply houses and steam specialty firms will remember Mr. Rhodes as the first representative of the Homestead organization, as he formerly traveled from coast to coast for the company in the appointment of sales representatives. Following his previous connection with the Homestead Co., Mr. Rhodes formed the Eastern Steam Specialty Co., New York, handling Homestead valves and other steam specialties.

LELAND D. O'CONNELL, who has centered much of his active business career in the Southwest, has been appointed Manager of their important Denver, Colorado office according to an announcement from the Westinghouse Electric and Mfg. Co.

Wm. Trudgian, former Manager of the office, has been promoted to the post of Special Representative and will care for the duties previously handled by L. M. Cargo who has retired.

For the Engineer's Library

ELECTRICAL ENGINEERS' HANDBOOK. Harold Pender, Ph.D., Sc.D., Editor-in-Chief, William A. Del Mar, A.C.G.I., and Knox McIlwain, B.S., E.E., Associate Editors-in-Chief. John Wiley & Sons, Inc., New York, 1936. Third Revised Edition. Electric Power Volume, 1300 Pages, 709 illustrations, 5⅝ by 8⅝ in., $6.00.

The third revised edition of Pender's "Electrical Engineers' Handbook" appears in a totally different form than heretofore. In accordance with the new concept of the function of the handbook, as evolved by an advisory board of editors of the Wiley Handbooks, and others, material fundamental to all engineering (i.e. mathematics, physics and chemistry) has been removed to a separate volume—Eshbach's "Handbook of Engineering Fundamentals," published in September. This arrangement enables more space to be devoted in the regular handbooks to the various phases of the specialized subjects. Also, the efficiency of "Pender" has been increased by its separation into two volumes, one dealing with Electric Power and the other with Electric Communication and Electronics. The encyclopedic arrangement used in earlier editions has been abandoned for a more practical sequence of topics. Together these two volumes cover every important topic of electrical engineering.

The Electric Power volume has been consolidated into nineteen sections, each dealing with a general topic. The treatment accorded to each topic has been handled so that each receives attention in accordance with the importance of the subject in relation to other subjects in the field. Controversial matters have been avoided. New topics, such as Air-conditioning, Electric Water-heating and Electricity in Agriculture, have been included, and topics of newly developed importance, such as Automotive Electrical Engineering and Industrial Application of motors have been given correspondingly greater prominence. Power Transmission and Distribution receives a large amount of space, since it was found that this subject is one on which former editions were most frequently consulted. The section headings include: Mathematics, Units, and Symbols; Properties of Materials; Electric Circuits and Electric Lines; Resistors, Reactors, Magnets; Measurements and Measuring Apparatus; Principles of Electrochemistry; Batteries; Direct-current Machines; Alternating-current Machines; Transformers; Converters and Rectifiers; Switching, Control, and Protection; Power Stations and Substations; Power Transmission and Distribution; Lighting and Heating; Industrial Applications of Motors; Transportation; Electro-chemical and Electrothermal Industries; Electricity on the Farm. Thirty-seven distinguished members of the electrical engineering profession collaborated with the editors in the preparation of this volume, which is listed as number IV in the new Wiley Engineering Handbook Series.

In addition to the division of material, the size of the handbook has been enlarged so that it now offers a trimmed page of 5½ by 8⅜ in. This increase in size allows the use of large, clear type, and larger and more readable illustrations and diagrams, a feature which should materially add to the utility of the volumes.

The outstanding contribution which the new "Pender" makes to engineering literature is the fact that no longer need the electrical engineer purchase a book containing much material of no direct use to him. The communication engineer may purchase only the volume covering this field; the power engineer likewise will probably want only the volume covering his particular interest. Thus each will secure the one volume essential to his work, and at a lower unit cost. Furthermore, he will find a greater amount of space devoted to each topic than was possible heretofore.

DEVELOPMENT OF DIESEL FUEL TESTING. By T. B. Hetzel. Published as Engineering Experiment Station Bulletin No. 45 by Pennsylvania State College, State College, Pa. Size 6 by 9 in., 55 pages, paper bound. Price 50c.

Considering the large amount of work being done in this phase of Diesel engineering at the present time by both engine manufacturers and oil companies, this bulletin is particularly timely. The first part of the bulletin discusses the relative merits and different methods of testing of Diesel fuels such as C.C.R., the knockmeter delay, the indicator method and fixed ignition lag. The reason for this detail being that the testing methods are not yet fully standardized and the author considered it advisable to give the industry the experience of the university with the various methods. The second part of the bulletin answers numerous questions on the effect of ignition lag and rating of such factors as ignition point, air intake pressure, jacket cooling temperatures. The author states that while the effect of the latter is great on the delay, the influence on the cetane rating is negligible and this conclusion is used to justify the optimism of many investigators regarding the ignition quality testing of fuels.

THE HANDBOOK OF CHEMISTRY AND PHYSICS. 21st edition. Chas. D. Hodgman, editor in chief. 4½ by 6⅝ in. 2028 pages. Bound in flexible artificial leather, gold edges. Published by Chemical Rubber Co., Cleveland, Ohio, 1936. Price $6.00.

The twenty-first edition of this well known book represents a 23 yr. accumulation of necessary data for the scientist and engineer that is highly essential in the commercial, educational and research laboratory. Constant revision year by year has made it one of the most up-to-date sources of reference available.

This edition represents an increase of over 175 pages of new composition entailed by complete revision of several important tables.

The Mathematical Section presents several new features. The numerical table of former editions has been replaced by a new and improved form. It now appears in two parts, the first of which gives the reciprocals and the circumference and the area of circles. The second part is devoted wholly to squares, cubes and roots, and all values are given to at least seven significant figures. The square roots of 10n and the cube roots of 10n are included. A table of haversines and considerable material on statistics have been added, and the order of arrangement altered so as to place the four- and five-place logarithm tables at the front of the volume.

The collection of laboratory arts and recipes has been completely revised and enlarged by material sent in by a large number of contributors in charge of or associated with educational or commercial laboratories.

The photographic section has been much enlarged and includes a large variety of new formulas and a completely revised table of plate and film speeds given in the Scheiner and in the Weston systems.

The increasing availability and widespread utilization of commercial plastics makes particularly appropriate the new and unusually complete collection of data for this class of material. The table occupies 17 pages and covers a very wide range of properties. A revised table of isotopes brings up to date the information in this rapidly changing field. Increasing convenience in the reduction of gas volume to standard conditions will result from the use of the new special table giving both the factors and their logarithms for such reductions. Several other small tables have been added and a large number of minor changes and partial revisions have been made.

Other important features of the handbook include:

1. A table of Physical Constants of over 5500 Organic Compounds named by Dr. Austin M. Patterson in accordance with the rules of the Committee on Organic Nomenclature of the International Union of Chemistry.
2. A formula Index of Organic Compounds in which some 5500 Organic Compounds are listed according to their empirical formulas and refer by number to the compounds given in the table, Physical Constants of Organic Compounds.

For convenience the Handbook is divided into five sections, approximately equal in size. These sections are indicated by inserts of stiff colored paper on which is printed a summary of the constants of the particular section. The divisions are as follows:

1. Mathematical Tables.
2. Properties and Physical Constants.
3. General Chemical Tables.
4. Heat, Hygrometry, Sound, Electricity and Light.
5. Quantities and Units—Miscellaneous Tables.

HIGH SPEED DIESEL ENGINES. By L. H. Morrison, Published by the American Technical Society, Drexel Ave. at 58th St., Chicago, Ill. Size 5½ by 8½ in., 236 pages, cloth bound. Price $2.50.

High speed Diesel engines have made such headway during the past ten years that they now demand consideration wherever small engine capacity is necessary. As pointed out by the author, of the 1,200,000 hp. Diesels built in 1935, almost a million were of the high speed type, operating at speeds ranging from 800 to 2200 r.p.m.

The first half of the book is taken up with a general consideration of high speed engines and its various component parts, while the second half is a detailed consideration of the many high speed engines now built in this country. The book was not written from the standpoint of the designer and although there is considerable information on the various phases of Diesel maintenance, no attempt has been made to be technical. It is rather a concise and comprehensive treatment of the high speed engine as such for the purpose of acquainting engineers and the engineering public with a particular type of engine which is becoming of increased commercial importance.

This is No. 4 in a series of Diesel engine books. The first three have been reviewed in earlier issues.

TECHNICAL DRAWING PROBLEMS, by Frederick E. Giesecke, Alva Mitchell, and Henry C. Spencer. Size 9x11 in., paper cover. Published by The Macmillan Co., New York, N. Y. 1936. Price, $1.40.

This book as stated by the authors in the introduction may be used in conjunction with any good reference text on technical drawing, but it has been designed especially to coordinate with their book "Technical Drawing". The book consists of 90 sheets, bound with perforated edges so that they may be removed from the book as needed and placed on a drawing board. Each sheet contains examples, underneath which or alongside of which space is provided for copying or completing the problems set forth by the examples. As shown in the work plan at the beginning of the book the problems are divided into units and general reference are given under each. The authors point out that these general references should be covered in lectures and recitations on the theory before the sheets in a given unit are assigned. The work sheets are beautifully executed and the student should find it a pleasure to follow them. The lettering exercises in particular are excellent and include a wide variety of styles and sizes. As to the authors; Frederick E. Giesecke is professor of engineering research and director of the Texas Engineering Experiment Station, Alva Mitchell is professor of engineering drawing and Henry C. Spencer is assistant professor of engineering drawing at the Agricultural and Mechanical College of Texas.

DIESEL ENGINE CONSTRUCTION Elementary Principles. Prepared by the members of the teaching staff at Mechanics' Institute of the Boys' Technical High School, Milwaukee. Published by The Bruce Publishing Co., 524 N. Milwaukee St., Milwaukee, Wis. Size 6 by 9 in., 120 pages, cloth bound. Price $1.80.

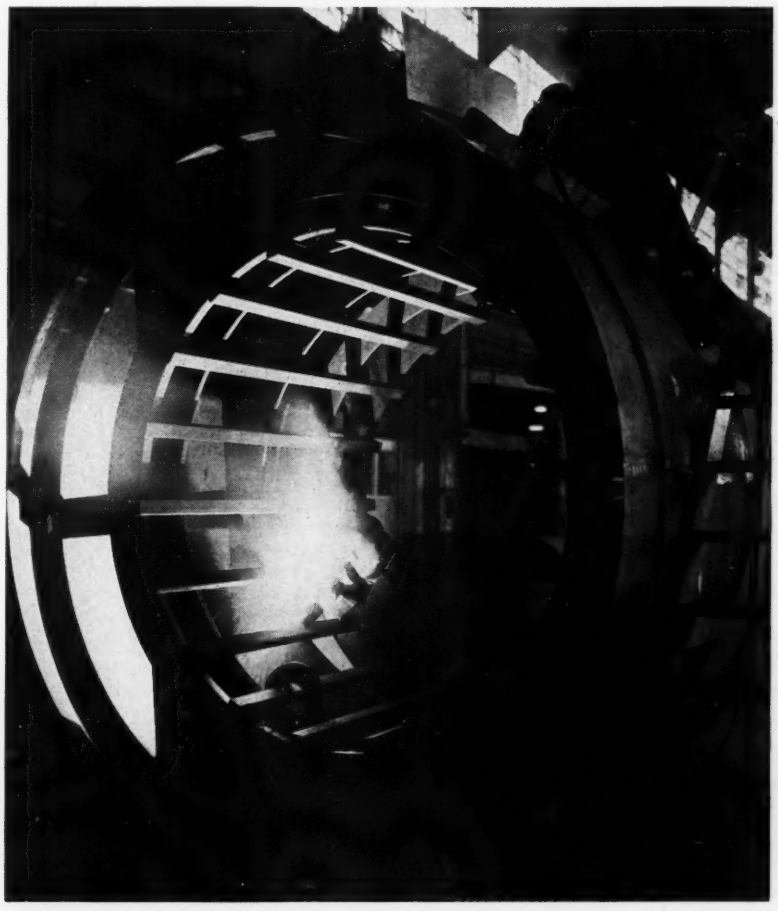
Several years ago progress in the internal combustion engineering field made it desirable to introduce a course of instruction in Mechanics' Institute of Boys' Technical High School in Milwaukee. This book is the result of development of an instruction manual for that course. It is not a text which requires a comprehensive knowledge of mathematics and engineering, but is intended for those interested in the elementary principles to so organize as to be helpful not only to the student, but the practical mechanic or operator. It is divided into 11 chapters which discuss development and construction from a historical and practical standpoint, considers different types of engines, fuel injection systems, starting systems, auxiliary equipment, fuel oils and lubricants, indicator practice and Diesel power applications.

QUESTIONS AND ANSWERS ON BOILER FEEDWATER CONDITIONING (Questions and Answers Handbook 3). By J. F. Barkley. Published by the Bureau of Mines. Size 4 by 6 in., 121 pages, paper bound. For sale by the Superintendent of Documents, Washington, D. C. Price 20c.

This is a very clearly written pamphlet presented in questions and answers form primarily for boiler operators who have not studied chemistry. Whether he understands it or not, the boiler operator must apply some chemistry and he usually receives instructions with the equipment as to how to proceed, but if he does not know why, he is working in the dark and neither he nor the equipment can reach full effectiveness. In addition to the text, there are in the back a number of tables giving the chemicals commonly used, their chemical formula and name and common name as well as other tables useful in connection with water treatment.

THE CRACKING ART IN 1935. By Gustav Egloff, Emma E. Crandal and Martha M. Doty. Published by the Universal Oil Products Co., 310 So. Michigan Ave., Chicago, Ill. Size 6 by 9 in., 330 pages, cloth bound.

This is a comprehensive review of the progress in cracking art during the past year and is arranged in 14 major sections. The status of cracking, both inside and outside of the United States; the economics of cracking; chemical reactions of the liquid and vapor phase; selective, oxidation, electrical cracking; polymerization of gases, together with treating of cracked products and cracking by-products are covered briefly with a summary of the various American and foreign patents issued in each division during the year.



GAS TIGHT WELDED GENERATOR FRAME

This gas tight welded generator frame section will be part of 58,000 kv-a. hydrogen cooled turbo-generator. The section shown is one-half of the frame and measures 138 in. in diameter and 104 in. in length. This section weighing almost 20 tons is entirely arc welded and is being fabricated in the East Pittsburgh shops of the Westinghouse Electric and Manufacturing Company. The welds are tested for tightness at a pressure of 80 pounds per square inch.

UTILITY CHART, 1936. Prepared and published by Robert A. Burrows, First National Bank Bldg., Pittsburgh, Pa. Chart size 34 by 28 in. Price, in black and white, $2; in colors, $3 per copy.

This chart shows at a glance the interrelation and capitalization of the principal public utility holding, operating and investment companies as of January 1, 1936. Over 500 companies are covered and although it was prepared primarily for financial and investment reference, it will be found valuable by all those interested in public utilities and their operation.

MECHANICAL ENGINEERS' HANDBOOK, Eleventh Revised Edition. Power. Robert T. Kent, Editor-in-Chief, and 28 contributors. John Wiley & Sons, Inc., New York, 1936. 1254 pages; illustrated; 5⅝ by 8⅝ in.; $5.00.

Kent's Mechanical Engineers' Handbook has for over 40 yrs. been the "bible" for mechanical engineers the world over. In this new edition, the eleventh, an entire change has been made in the format and arrangement of this well known handbook. Its content is now divided into two sections, one dealing with the entire field of power and its applications that is of interest to the mechanical engineer, the other covering in detail present-day methods in design and shop practice, and each section occupying an entire volume. These volumes may be purchased separately or in combination. This arrangement of material is far more practical than the old set-up, for the engineer will now find all necessary information in each field conveniently gathered in one compact volume; he is thus free from the necessity of going through a large amount of irrelevant material to find what he seeks. This review will deal solely with the Power volume, since Design and Shop Practice will not appear until the spring of 1937.

Special mention should be made of the new format in which "KENT" appears. In line with the new plan of design of the Wiley Engineering Handbook Series, of which the Power volume is number II, this volume measures 5⅝ by 8⅝ in. The increased size of the book permits the use of large, clear type, illustrations and diagrams, a feature which greatly enhances the practicality of the book.

There are seventeen sections in the Power volume, followed by an unusually complete index. Section I, Air, includes not only a description of the properties of air, but a discussion of the flow of air and a full treatment of air compression, including fans and blowers. Section II, Water, covers the fundamentals of hydraulics including material on flow of water, turbines, pumps and pumping engines. Section III, Heat, offers treatments of the measurement of heat, heat transmission, evaporators and evaporation, dryers and drying, heat insulation and thermodynamics. A section on Combustion and Fuels follows covering the principles of combustion.

Section V gives information concerning Steam, with extensive data as to its properties, steam piping and steam valves. Section VI applies these principles of the action of steam to the steam boiler, offering thorough descriptions of the various types of steam boilers, their performance, construction and other important data. Section VII follows with a discussion of important data concerning the steam engine, while Section VIII covers fully the types, performance, etc., of the steam turbine. Section IX deals with condensing and cooling equipment, and Section X with refrigeration and ice making.

Section XI is devoted to heating, ventilating and air-conditioning. Section XII discusses internal combustion engines. Gas producers receive full attention in Section XIII. Section XIV is entitled transportation, and covers what the mechanical engineer needs to know about railroad engineering, automotive vehicles and aeronautics. Section XV gives a brief summary of the fundamentals of electric power, offering much-needed information on purchased power, generated power, conversion equipment, switchboard equipment, batteries, power factor and power distribution. Power Test Codes are discussed fully in Section XVI, not only as to instruments and apparatus but also as to test codes themselves. The final section gives a complete and accurate set of mathematical tables of vital importance to the mechanical engineer.

GEO. P. REINTJES CO., Kansas City, Mo., has issued its bulletin No. 101 entitled "Standardized Walls" which describes in detail the construction of various types of Reintjes walls and points out the many advantages which this patented construction presents.

CORNELL IRON WORKS, INC., of Long Island City has just published a new eight page catalogue of rolling doors and shutters, hand and motor operated. It gives a description of types, illustrations, and photographs of steel and bronze doors in place. Full tables of dimensions and clearances are given for automatic closing rolling doors labeled by Underwriters' Laboratories, Inc., for fire walls, etc.; as well as standard rolling doors.

U. S. RUBBER PRODUCTS, INC., 1790 Broadway, New York, has recently issued a practical manual which will serve as a ready reference for engineers, plant operators and executives in the application of rubber mountings to modern industrial use. These mountings have considerable application for the elimination of vibration in industry and in the home and it is believed will play a more important part in future engineering projects than they have in the past. The book gives engineering data indicating the various characteristics of rubber, graphs showing its deflection curves and its safety load limits.

BULLETIN No. 7066 of the Cameron Pump Div. of Ingersoll-Rand Co., Phillipsburg, N. J., covers the line of direct connected centrifugal pumps, ranging in capacity from 150 to 5000 g.p.m., against heads of from 20 to 250 ft. These pumps are used for handling practically all liquids and the bulletin shows photographs of many installations and construction details of the various types.

LINCOLN Shield-Arc SAE Welder, its action, construction and operation are described and illustrated in Bulletin No. 412 of the Lincoln Electric Co., Cleveland, Ohio.

HOW TO REDUCE maintenance expense on industrial roofs is discussed simply and with numerous illustrations in a new 28-page booklet entitled "Things You Should Know About Your Roof" published by Johns-Manville Corp., 22 E. 40th St., New York City. Some subjects treated are, how roof troubles start, and how best to prevent them, how roofing felts should be laid, how flashing should be applied, how the joints in the coping should be protected, and how roofing should be placed around drains, skylights and angle supports.

AUTOMATIC PRIMING, electrically operated centrifugal pumps are described in Bulletin W323-B1A issued by the Worthington Pump & Machinery Corp., Harrison, N. J. Compressed Air at Lower Cost is the title of a 4-p. bulletin issued by the same company.

TIMKEN STEEL & TUBE CO. has just prepared a new 8-p., 8½ by 11 in. booklet of additional information on the Sicromo 1, 2, 3 and 5 steels recently announced, giving the analyses of these new steels and the effect of silicon and chromium on the oxidation resistance of steels in which they are used.

ECONOMICAL WAYS of Making Splices in circuits from No. 12 B & S gauge wire to 350,000 c.m. cable with "Anaconda" rolled and drawn seamless connectors are given in publication C-8 of the Anaconda Wire and Cable Co. of New York City.

MIXFLO centrifugal pumps, made by the Worthington Pump & Machinerv Corp., Harrison, N. J., are described in an 8-p. bulletin, W-313-B1. These pumps range in size from 12 to 84 in., capacities from 1000 to 225,000 g.p.m. and heads from 5 to 50 ft. They are used for irrigation, drainage, sewage disposal and condenser circulation service.

TURBO BLOWERS FOR THE STEEL INDUSTRY are described in a new leaflet, 2236, issued by Allis-Chalmers Mfg. Co., Milwaukee, Wis.

TYPE T TURBINE PUMPS, as made by Roots-Connersville Blower Corp., Connersville, Ind., are described in a new bulletin, 260-B11B. The capacity of these pumps ranges from 5 to 200 g.p.m., with heads up to 700 ft. Although the bulletin is concerned primarily with industrial applications, the Type T pump is made in a complete line for domestic water systems, condensate return and boiler feed purposes. A line of self-priming pumps for handling volatile liquids is now being developed.

AMERICAN DUSTUBE Dust Control is a 24-p. data book, No. 22, issued by American Foundry & Equipment Co., Mishawaka, Ind., describing the control and giving data on exhaust piping, pressures, air volumes and the solving of particular problems in dust collection and disposal.

COMPARATIVE ECONOMIES of constant and of variable speed drives for centrifugal pumps, also the several methods of obtaining variable speed are discussed in a paper by A. Peterson, chief engineer of the Centrifugal Pump Department of De Laval Steam Turbine Co., Trenton, N. J., in a paper reprinted from the Journal of the American Waterworks Assn. He argues that, for maximum efficiency, delivery should be controlled by varying the speed. Copies may be had on application to the De Laval Steam Turbine Co.

TYPE S Diesel engine of the Ingersoll-Rand Co., New York City, is described and illustrated in an 8-p. folder recently issued.

HANCOCK VALVE DIVISION of Consolidated Ashcroft Hancock Co., Bridgeport, Conn., has just released a four reel motion picture which has been expressly prepared for showing to mill supply houses.

ARC WELDING HANDBOOK, Fourth Edition, 819 pp., 990 illustrations; 6 by 9 in. Flexible leatheroid cover. Lincoln Electric Co., Cleveland, Ohio. Price, $1.50.

To present new data, 223 pages and 289 cuts have been added, covering the Welding Generator, Types of Joint, Insurance of Fusion Welded Vessels, Codes, Cutting, Sheet Metal Welding, Electrode Size, Testing Weld Metals, Monel Metal, Surfacing by Welding, Design with Standard Shapes, Plate Girders. Other material has been revised to cover present day practice, with the object of presenting a complete reference guide for designers, production managers, supervisors and operators. The subjects of the eight sections are: Welding Methods and Equipment; Technique of Welding; Procedure, Speeds and Costs for Welding Mild Steel; Structure and Properties of Weld Metal; Weldability of Metals; Design of Machinery for Arc Welded Construction; Designing for Arc Welded Structures; Applications in Manufacturing, Construction and Maintenance.

LINK-BELT automatic coal stokers for industrial, commercial and residence use is the subject of a new 28-p. Book No. 1619 issued by Link-Belt Co., 2410 W. 18th St., Chicago, Ill. It covers the combustion cycle in underfeed stokers, burning heads to fit the coal available, agitated fuel bed, automatic air control and results from operation. Request to the Company will bring a copy.

ALLIS-CHALMERS MFG. CO. of Milwaukee, Wis. has just released an attractively illustrated 24-page engineering bulletin 1183 on their type DFR Distribution Feeder Voltage Regulators designed for regulating voltage under load on feeders or busses similar to applications where the induction type of feeder regulator has heretofore been used, as well as for larger ratings than heretofore found economical. As distinguished from the motor principle involved in the induction type of regulator, this bulletin deals with feeder regulators operating on the transformer and tap-changing-under-load principle, capable of being furnished in single or three phase units, for any frequency, for indoor or outdoor application, with oil-immersed current limiting reactors built integral, if desired, for automatic or non-automatic control, and with or without line drop compensation.

TYPE EN GAS ENGINES are described in a new four-page bulletin in colors issued by the Cooper-Bessemer Corp., Mt. Vernon, Ohio. This engine was originally designed as a Diesel engine and is easily convertible from one to the other fuel. It is rated at 30 to 38 hp. per cylinder and built in 3, 4, 6 and 8 cylinder units.

STANDARDS ON COAL AND COKE, giving sampling methods, chemical analysis, testing methods, specifications and classifications and definition of terms, has just been published by the American Society for Testing Materials, 260 N. Broad St., Philadelphia, Pa. This book, combining all the coal and coke standards in their latest approved form, is 6 by 9 in. in size, 145 pp., paper bound and may be obtained from the headquarters of the Society for $1.25 (special prices on 10 or more copies).

MAKING AND SHAPING of Alloy Constructional Steels, by E. C. Smith, has just been published as Bulletin F-1 by the International Nickel Co., Inc., 67 Wall St., New York, N. Y.

AMONG THE tentative specifications and revisions recently adopted by the American Society for Testing Materials, the following are of special interest to the power plant field: High-Strength Structural Rivet Steel; Seamless Boiler Tubes for High Pressure; Alloy-steel Bolting Material for High Pressure and Temperatures to 1100 deg. F.; Nuts for Bolting in High-Pressure Service and Temperatures to 1100 deg. F.; Testing Methods for Coarse and for Fine Concrete Aggregates; Wrought Iron Plates; Insulated Wire and Cable; Tests of Varnishes for Insulation; Tests of Insulating Materials for Dielectric Strength.

New and revised standards have been adopted as follows: Revision on Testing of Molded Electrical Insulation; Welded and Seamless Steel Pipe, both Black and Hot Galvanized; Bare Stranded Copper Cable; Resistance of Refractory Brick to Spalling; High-Early-Strength Portland Cement; Resistance to Spalling of High Heat Duty Fireclay Brick.

Copies of the above may be obtained from the Society, 260 S. Broad St., Philadelphia, Pa.

NORGREN Pneumatic products, including lubricators, regulators and valves made by C. A. Norgren Co., Inc., of Denver, Colo., are shown in Catalog No. 200 of that company.

NATIONAL Toridheet cast-iron oil-burning heating boilers, as made by the National Radiator Corp., Johnstown, Pa., are described and illustrated in a booklet recently issued.

KEEP BOILERS EFFICIENT is the title of a folder which has just been published by the Bloomfield Chemical Co., 169 Bloomfield Ave., Bloomfield, N. J., manufacturers of Scale-Kem. The folder treats the subjects of water, scale, prevention of scale, and corrosion, and explains how to keep boilers clean scientifically.

ALLIS-CHALMERS MFG. CO., Milwaukee, Wis., has issued a revised 28 page Bulletin 1154A covering the construction and numerous uses of their modern coupled and engine type synchronous motors that may now be obtained with torque characteristics suitable for practically any drive, 50 hp. or over, where the squirrel cage induction motor could be used. It deals with the increasing usage of this type of motor due to its uniform high efficiency, at fractional as well as at full loads, and at all speeds, together with its all important function of power factor correction.

POWER PLANT measuring instruments, telemeters and automatic controls as built by Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa., are covered in a new bulletin, Broadside No. 160, just released. Various instrument models are illustrated and described and the specific uses of these instruments in electrical and mechanical operating departments summarized.

THE BROWN INSTRUMENT CO., Philadelphia, Pa., has just published a new catalog, No. 6703, on Brown Thermometers and Pressure Gauges which covers the complete line of Brown thermometers and pressure gauges—indicating, recording and controlling—and enumerates the wide range of industries to which they are applicable.

THINGS YOU SHOULD KNOW About Your Roof are given in a 26-p. booklet by Johns-Manville, New York City, showing the effects of rain and sun, also proper methods of roof construction.

PROCEDURE HANDBOOK of Arc Welding Design and Practice in its fourth edition is issued by The Lincoln Electric Co., Cleveland, Ohio. It contains 819 pages, 223 of which are recent data on arc welding, covering methods and equipment, procedure for all kinds of metals, methods of design for arc-welded construction and typical applications. Bound in flexible simulated leather, 6 by 9 in., fully illustrated. Price $1.50.

BEAVER PIPE TOOLS, Inc., Warren, Ohio, has recently issued a bulletin which is in the form of a condensed catalog describing the various Beaver Pipe tools, giving sizes and prices. One of the strictly new tools is designated as No. 60-R rachet in sizes from ¼ to 1¼ in. which has a number of features which appeal to pipe fitters.

"THE INSIDE Story of Boiler Water Conditioning" is the title of a new 16 page bulletin recently issued by the Elgin Softener Corp., Elgin, Ill. This bulletin is a non-technical discussion of various methods of water treatment and shows the importance of selecting the right method to handle the conditioning of various waters, emphasizing the necessity for a thorough understanding of the subject if the boiler room is to be efficiently operated.

OLDHAM "MULTI" TOOL CO., 24 Water St., New York City, has issued a folder describing the Geometric Divider Plate which is a drawing tool for architects, engineers, draftsmen, designers, teachers and students, conveniently used for drawing geometric figures and may also be used as a protractor.

HAHN ENGINEERING CO., 30 Church St., New York, has just issued a folder describing and illustrating the Hahn cast-iron sectional storage units which are used for tanks, bunkers, hoppers, bins and silos containing coal, coke, ashes, clinkers, sand, gravel and other materials of corrosive or abrasive nature.

HISTORIES of the various companies making up Baldwin-Southwark are contained in a Centenary Issue of the company's quarterly. It covers the life of Samuel V. Merrick, who was one of the active founders of Franklin Institute and started the firm of Merrick & Towne and the Southwark Foundry in 1836. Progress and achievements of Southwark, of De La Vergne Machine Co., of I. P. Morris and of Pelton Water Wheel Co., all now subsidiaries of Baldwin-Southwark are given in detail.

MATERIAL HANDLING EQUIPMENT, a new catalog, has been issued by Gifford-Wood Co., Hudson, N. Y. The book contains, besides detailed descriptions of equipment, many tables and drawings which should prove valuable in planning and designing new or modernizing old material handling plants.

IN Dual Service News, Hagan Corp. presents results obtained by users of its combustion control and water conditioning systems, also interesting comments on its services and why they are needed for power plants and water supplies.

Power Plant Construction News

Calif., Los Angeles—Telegraph Refinery, Inc., Anaheim-Telegraph Road, plans installation of power equipment, pumping machinery, steel tanks and other equipment, in connection with rebuilding of portion of oil refining plant, recently destroyed by fire. Loss estimated close to $100,000.

Calif., Riverside—National Ice & Cold Storage Co., Twelfth Street, plans new three-story addition to local ice-manufacturing and pre-cooling plant. Entire project will cost over $85,000, including equipment.

Conn., Bridgeport — Sprague Meter Co., South Street, plans installation of electric power equipment in two new two-story additions to gas meter manufacturing plant. Entire project will cost close to $60,000. Leo F. Caproni, New Haven, Conn., is architect.

Fla., De Land—City Council has plans maturing for new municipal electric light and power plant, estimated to cost close to $400,000, including distributing lines. Proposed to arrange bond issue and carry out financing through Federal aid. Bids will be asked in near future.

Ga., Albany—Albany Mfg. Co., recently organized, plans installation of electric power equipment in new one-story hosiery mill, 120x210 ft. Entire project will cost over $65,000. Charles A. Blatchley, Drexel Building, Philadelphia, Pa., is engineer.

Ill., Chicago—Sherwin-Williams Co., Cottage Grove Avenue and East 115th Street, plans installation of electric power equipment in new four-story addition to local paint and varnish plant, 100x200 ft. Entire project will cost over $100,000. Main offices of company are at 101 Prospect Avenue, N. W., Cleveland, Ohio.

Ill., La Grange—Electro-Motive Corporation, manufacturer of diesel-electric locomotives, plans installation of electric power equipment in one-story addition to plant, about 85,000 sq. ft. floor space, scheduled to be completed next spring. Building contract has been let to Austin Co., 16112 Euclid Avenue, Cleveland, Ohio. Entire project will cost about $750,000. Company is a subsidiary of General Motors Corporation, General Motors Building, Detroit, Mich.

Iowa, Cedar Falls—Viking Pump Co., plans installation of electric power equipment in proposed new addition to pumping machinery manufacturing plant. Entire project is reported to cost over $75,000.

La., Rodessa—Cass-Liberty Gasoline Co., First National Bank Building, Dallas, Tex., plans installation of air compressors, pumping machinery, power equipment, steel tanks and other equipment in new natural gasoline refinery near Rodessa, where site has been acquired. Entire project will cost over $200,000. Petroleum Engineering Co., Philtower Building, Tulsa, Okla., is engineer and will supervise erection.

Mass., Fall River—Celanese Corporation of America, Inc., 180 Madison Avenue, New York, N. Y., plans installation of electric power equipment in new cellulose rayon mill at Fall River, where company has acquired former plants of American Linen Co., and American Printing Co., and will remodel and expand. Entire project will cost close to $750,000.

Mich., Gladstone—City Council has plans nearing completion for new municipal electric light and power plant, using diesel engine-generator units and accessories. Special election has been called Dec. 15 to approve bond issue of $100,000 for project. Shoecraft, Drury & McNamee, Ann Arbor, Mich., are consulting engineers. E. H. Waterhouse is city manager.

Mich., Lansing—Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich., plans installation of power equipment, electric hoists and other mechanical-conveying equipment in new foundry in vicinity of McKinley Street, Lansing. Structure will be built by Motor Wheel Corporation, Lansing, and equipped and occupied by first noted company for production for latter organization. Entire project will cost about $850,000.

Mich., Lansing—City Council, City Hall, plans installation of power equipment, pumping machinery, mechanical-handling and other equipment in new municipal sewage and garbage disposal plant. Entire project will cost about $900,000, of which $405,000 is being secured through Federal aid. Work is scheduled for completion early in 1938.

Minn., Sherburne — Federated Rural Electric Association, Jackson (Jackson County), Minn., P. L. Ferguson, secretary, recently organized, is considering construction of a steam-operated electric power plant at Sherburne, for power supply for rural electrification system to be built in that district. Entire project is reported to cost over $125,000.

Neb., Beatrice—Store Kraft Mfg. Co., plans installation of electric power equipment in proposed additions to store fixture and equipment manufacturing plants. Company is arranging financing to total over $150,000, considerable portion of fund to be used for purpose noted.

N. J., Kearny—Coca Cola Co., Atlanta, Ga., plans installation of electric power equipment in new Eastern branch plant on Lincoln Highway, Kearny, where tract of six acres of land has been acquired. New beverage plant will comprise several units, including boiler house. Entire project is reported to cost close to $500,000.

N. Y., Buffalo—Buffalo Sewer Authority, City Hall, will receive bids until Dec. 8 for equipment for new sewage treatment plant on Bird Island, including six motor-driven vertical shaft pumping units with complete accessories, each with rated capacity of 120,000,000 gals. per day (estimated cost $250,000); also for transformers, switchgear and other electrical equipment (estimated cost $84,000), motor-driven sluice gates, tanks and other equipment. Entire project will cost close to $2,000,000.

Ohio, Berea—City Council has plans maturing for extensions and improvements in municipal electric light and power plant, with installation of new generating equipment and accessories. Estimated cost about $80,000. William C. Kammerer & Associates, 823 Prospect Avenue, Cleveland, Ohio, are consulting engineers.

Ohio, Ohio City—Village Council has plans nearing completion for municipal electric light and power plant, using diesel engine-generator units and accessories. Fund of about $45,000 has been secured through Federal aid.

Ohio, Toledo—Gulf Refining Co., Gulf Building, Pittsburgh, Pa., plans installation of power equipment, pumping machinery, steel tanks and other equipment in connection with proposed additions to oil refining plant at Toledo for large increase in present capacity. Entire project will cost over $500,000. Company engineering department is in charge.

Pa., Altoona—Altoona Silk Corporation, Altoona, recently organized, plans installation of electric power equipment in new local mill. Entire project will cost about $65,000. Altoona Chamber of Commerce is interested in enterprise, and will erect building and lease to company for long term.

Tenn., Cleveland — Dixie Foundry Co., plans installation of power equipment, mechanical-handling and other equipment in two new additions to local plant. Entire project will cost close to $100,000. S. B. Rymer is president.

Texas, Harlingen—Fidelity Products Co., Brownsville, Tex., plans installation of power equipment in new cottonseed oil mill at Harlingen, where large tract of land has been acquired on Valley Fair Boulevard. A power house is proposed. Work is expected to begin early in 1937. Entire project will cost over $50,000.

Texas, Harlingen—Inco Packing Co., Coffeyville, Kan., plans installation of electric power equipment in new two-story meat-packing plant at Harlingen. Entire project will cost about $55,000. It is proposed to begin work soon.

Texas, Houston—American Can Co., 230 Park Avenue, New York, N. Y., plans installation of electric power equipment in proposed new multi-unit plant at Lockwood Street and Clinton Drive, Houston, where 14-acre tract of land was recently acquired. Entire project will cost over $600,000.

Wash., Wenatchee—Chelan Copper Co., Seattle, Wash., has made application for permission to construct and operate a hydroelectric generating plant on Lake Chelan, where site has been selected at place known as Railroad Creek. Power dam will be built at last noted location. Initial plant will be equipped for capacity of about 3000 kw., and will include a transmission line, about 11 miles long, to mining properties of company, for power supply. Entire project will cost over $300,000.

W. Va., Wheeling — Baltimore & Ohio Railroad Co., Baltimore, Md., has plans under way for new one-story cold storage and refrigerating plant at Twentieth and Water Streets, Wheeling, 110x120 ft., estimated to cost close to $100,000, including equipment. Engineering department will be in charge.

Wis., Marshfield — Berg Equipment Co., South Maple Street, manufacturer of structural products for farm service, plans installation of electric power equipment in new two-story plant addition, 84x112 ft. Cost over $50,000. Superstructure will begin soon.

Here are drives... dependable and economical!

This group of machines represents a single order from a nationally famous manufacturer who values dependability. These eight machines are

ELLIOTT
Mechanical Drive
TURBINES

Elliott builds

TURBINE-GENERATORS . . . MECHANICAL DRIVE TURBINES . . . STEAM ENGINES . . . ENGINE-GENERATORS . . . CONDENSERS MOTORS and GENERATORS . . . DEAERATORS . . . FEED-WATER HEATERS . . . CENTRIFUGAL BLOWERS . . . DESUPERHEATERS . . . VACUUM COOLING UNITS . . . STEAM JET EJECTORS . . . TUBE CLEANERS . . . SEPARATORS . . . STRAINERS . . . GREASE EXTRACTORS . . . NON-RETURN VALVES

H-605b

HIGH DEPENDABILITY is one of the reasons for the popularity of Elliott turbines for driving all sorts of centrifugal pumps, coal pulverizers, fans, etc.

Other intrinsic advantages are low maintenance, the ability to handle overloads, the fact that the turbines are dustproof, without fire hazard, easily controlled for variable speeds, that the clean exhaust steam can be used in process, or the turbine can operate on exhaust steam from other units.

Elliott mechanical drive turbines can drive direct at speeds of 1200 to 3600 r.p.m. For lower speeds they are equipped with very compact built-in gears, as illustrated above. Elliott turbines are built in a complete range of sizes and for any steam pressure or back pressure desired. They can fit your heat balance.

It is that extra built-in, rugged dependability of Elliott mechanical drive turbines that appeals so strongly to users. You can check for yourself their high-grade design and construction. Ask for Bulletin H-9.

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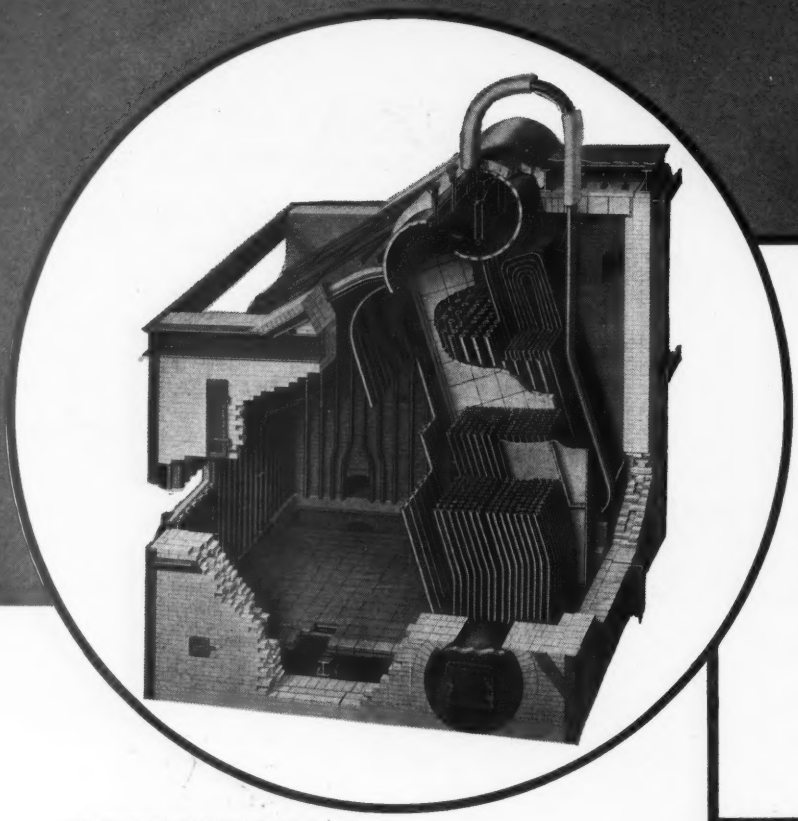
Steam Turbine Department: JEANNETTE, PA.

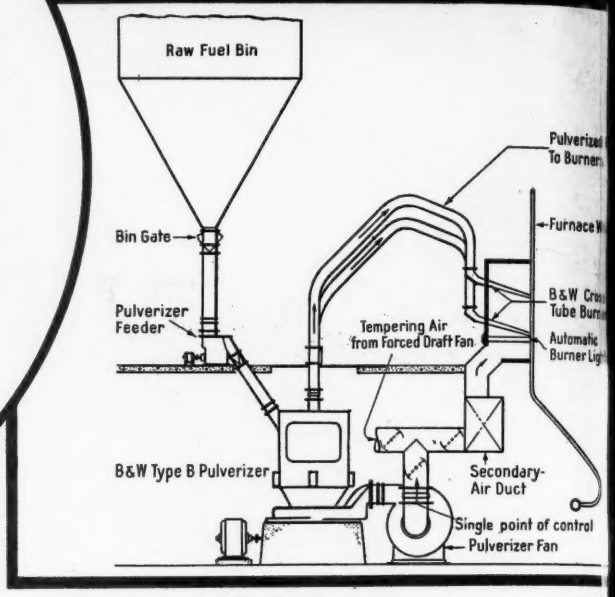
District Offices in Principal Cities

Published monthly by the Technical Publishing Co. at 53 W. Jackson Blvd., Chicago. Subscription price $2.00 a year. Single copies current issue, 25c. Entered as second class matter September 5, 1932, at the Post Office, Chicago, Ill., under act of March 3, 1879. Vol. XL, No. 12.



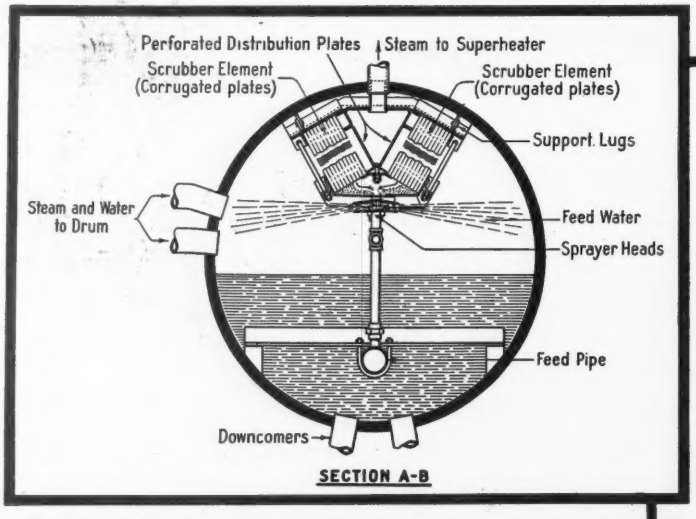
INTEGRAL-FURNACE BOILER— A complete boiler unit with integral water-cooled furnace, for moderate capacities.

A sectionalized model on display at New York Power Show.

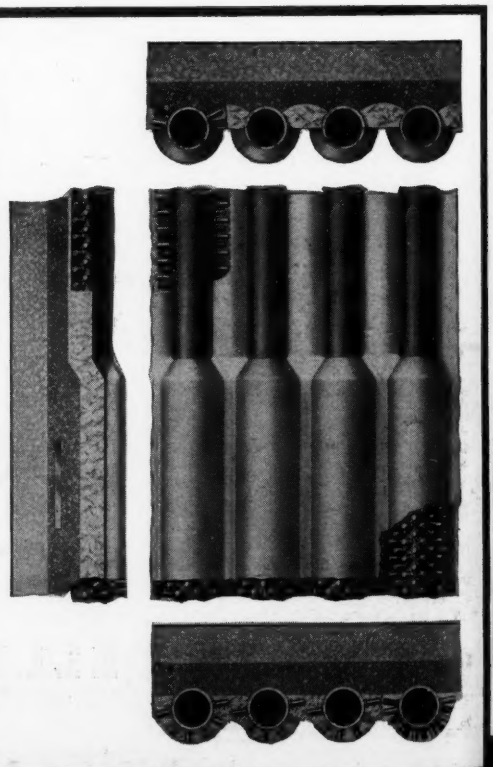


B&W DIRECT-FIRING SYSTEM—A fully coordinated direct-firin pulverized-coal system for a wide range of boiler sizes, coals, an operating conditions.

A full-size B&W Type B Pulverizer as used in this system will b in operation at the New York Power Show.



B&W STEAM SCRUBBER—Reduces solids and moisture in steam to greatest extent possible to date. Shown in operation at New York Power Show.



OTHER B&W EXHIBITS—Drawings and data describing construction features of recent designs of boiler units.

Firebrick, refractory mortars and plastics, and insulating firebrick.

Grinding elements that have been in service over 19000 hours in a B&W Type B Pulverizer.

Data on direct firing of rotary kilns with B&W Type B Pulverizers.

BAILEY STUD-TUBE WALL

A water-wall construction providing safety, durability, and adaptability to furnace design and operating requirements.

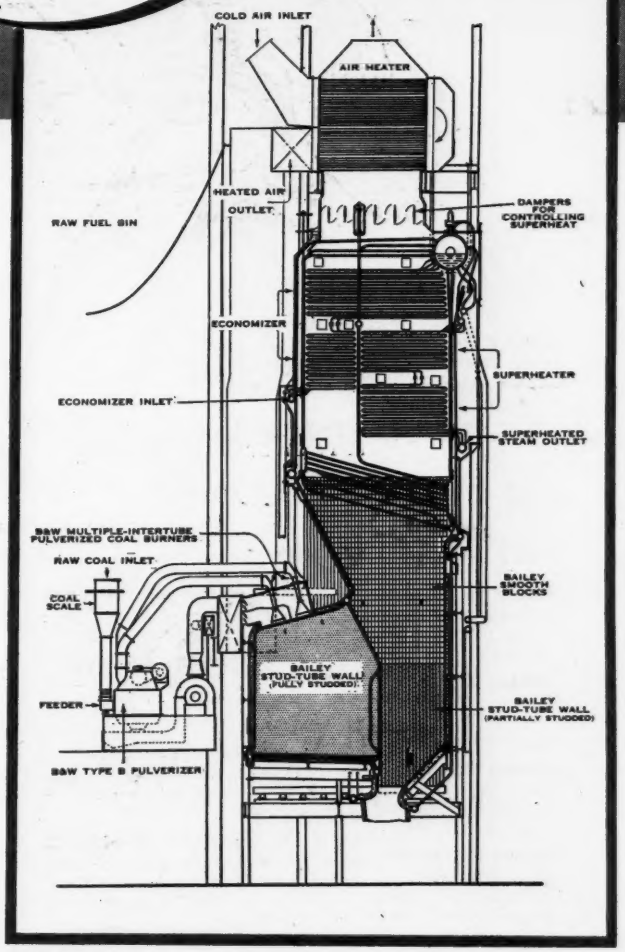
Full-size sections of this construction and of a Bailey Block-Covered Wall are exhibited at New York Power Show.

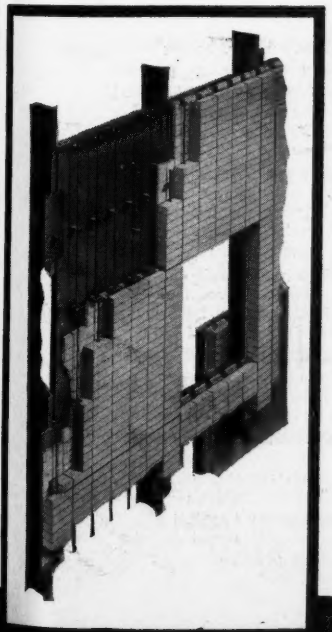
THE BABCOCK &

Recent BOILER DEVELOPMENTS *on display at New York Power Show*

The detail constructions shown on these pages reflect the progressive engineering policy of The Babcock & Wilcox Company that makes new equipment available to meet the ever changing requirements in steam power plants.

The BABCOCK & WILCOX COMPANY
85 LIBERTY STREET, NEW YORK





B&W INSULATING-FIRE-BRICK CASING-PANEL CONSTRUCTION — A thin, light-weight, insulated boiler casing, sectionally constructed.

Large-scale reproduction of accompanying illustration will be shown at New York Power Show.

HIGH-HEAD SINGLE-PASS CROSS-DRUM BOILER—A boiler designed for straight-through flow of gases, high capacities, high pressures, high temperatures, and superheat control.

TWO-STAGE FURNACE—Increases fluidity of ash for tapping and minimizes tube fouling.

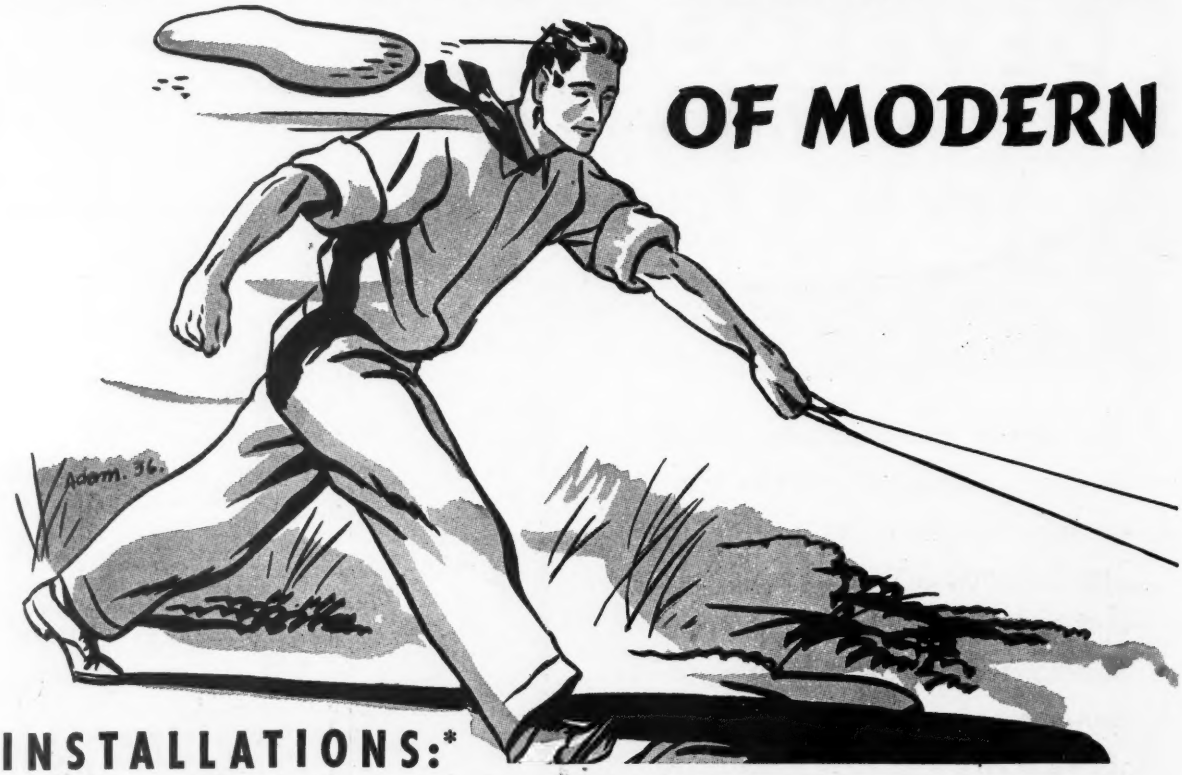
Large-size wash drawing at New York Power Show.

B&W SEAMLESS BOILER TUBES—Made by a process that demands steel of guaranteed quality, that tests and actually improves the steel. Over three hundred million feet produced to date.

Data on manufacturing process and samples of tubes will be shown at the New York Power Show.

WILCOX COMPANY

ALL TRAILS LEAD TO OF MODERN



INSTALLATIONS:*
INSTALLED OR SPECIFIED DURING 1936

ARMOUR and CO.
North Bergen, New Jersey
2-400 h.p. boilers
oil fired

AUGLAIZE BOX BOARD COMPANY
St. Marys, Ohio
1-100,000 lbs/hr., boiler
pulverized coal fired

BEECHNUT PACKING CO.
Canajoharie, New York
1-50,000 lbs/hr., boiler
pulverized coal fired

CELANESE CORPORATION
Amcelle, Maryland
1-150,000 lbs/hr., boiler
stoker fired

CHEVROLET MOTOR CO.
Indianapolis, Indiana
2-45,000 lbs/hr., boilers
stoker fired

CINCINNATI GAS and ELECTRIC CO.
Cincinnati, Ohio
3-350,000 lbs/hr., boilers
pulverized coal fired

COMMONWEALTH EDISON CO.
Chicago, Illinois
2-412,500 lbs/hr., boilers
pulverized fuel fired

MUNICIPAL UTILITIES
Fort Collins, Colorado
2-30,000 lbs/hr., boilers
stoker fired

CIA CUBANA de ELECTRICIDAD
Havana, Cuba
4-stoker fired boilers

GARDNER-RICHARDSON CO.
Lockland, Ohio
1-150,000 lbs/hr., boiler
stoker fired

GLOBE OIL and REFINING CO.
Lemont, Illinois
3-300 h.p. boilers
oil and gas fired

HOLYOKE WATER POWER CO.
Holyoke, Massachusetts
1-200,000 lbs/hr., boiler
oil and pulverized coal fired

INLAND STEEL COMPANY
East Chicago, Indiana
1-350,000 lbs/hr., boiler
gas and coal fired

KELSEY-HAYES WHEEL CO.
Detroit, Michigan
1-58,000 lbs/hr., boiler
pulverized fuel fired

KREY PACKING COMPANY
St. Louis, Missouri
2-40,000 lbs/hr., boilers
stoker fired

MUNICIPAL UTILITIES
Marshall, Missouri
1-325 h.p. boiler
stoker fired

NEWTON FALLS PAPER CO.
Newton Falls, New York
1-55,000 lbs/hr., boiler
pulverized coal fired

CITY OF NEW YORK
56th Street Incinerator
New York, New York
2-501 h.p. boilers
incinerator gas and oil fired

CITY OF NEW YORK
Flushing Destructor Plant
Flushing, Long Island, New York
2-260 h.p. boilers
incinerator gases and oil fired

PITTSBURGH PLATE GLASS CO.
Barberton, Ohio
1-180,000 lbs/hr., boiler
stoker fired

POST PRODUCTS
Division of General Foods Corp.
Battle Creek, Michigan
1-100,000 lbs/hr., boiler
pulverized coal fired

PRAIRIE STATE PAPER MILLS
Joliet, Illinois
1-35,000 lbs/hr., boiler
pulverized fuel fired

MUNICIPAL WATER and LIGHT PLANT
Princeton, Illinois
1-500 h.p. boiler
pulverized fuel fired

ROME STATE SCHOOL
Rome, New York
2-42,500 lbs/hr., boilers
stoker fired

SACRED HEART SANITARIUM
Milwaukee, Wisconsin
2-20,000 lbs/hr., boilers
pulverized coal fired

SISTERS OF PROVIDENCE
St. Mary of the Woods,
Terre Haute, Indiana
2-24,000 lbs/hr., boilers
stoker fired

STANDARD OIL CO., of CALIFORNIA
Richmond, California
3-125,000 lbs/hr., boilers
gas, oil and acid sludge fired

UNION BAG & PAPER COMPANY
Savannah, Georgia
3-50,000 lbs/hr., boilers
oil fired
3 recovery boilers

UNITED ILLUMINATING CO.
Bridgeport, Connecticut
2-100,000 lbs/hr., boilers
pulverized coal fired

THE VISCOSE CO.
Marcus Hook, Pennsylvania
2-50,000 lbs/hr., boilers
pulverized fuel or oil fired

WEST VIRGINIA PULP and PAPER CO.
Williamsburg, Pennsylvania
2-100,000 lbs/hr., boilers
pulverized coal fired

WILLMAR STATE ASYLUM
Willmar, Minnesota
2-302 h.p. boilers
stoker fired

*32 of the 58 Smoot Combustion Control Systems installed or specified during 1936.

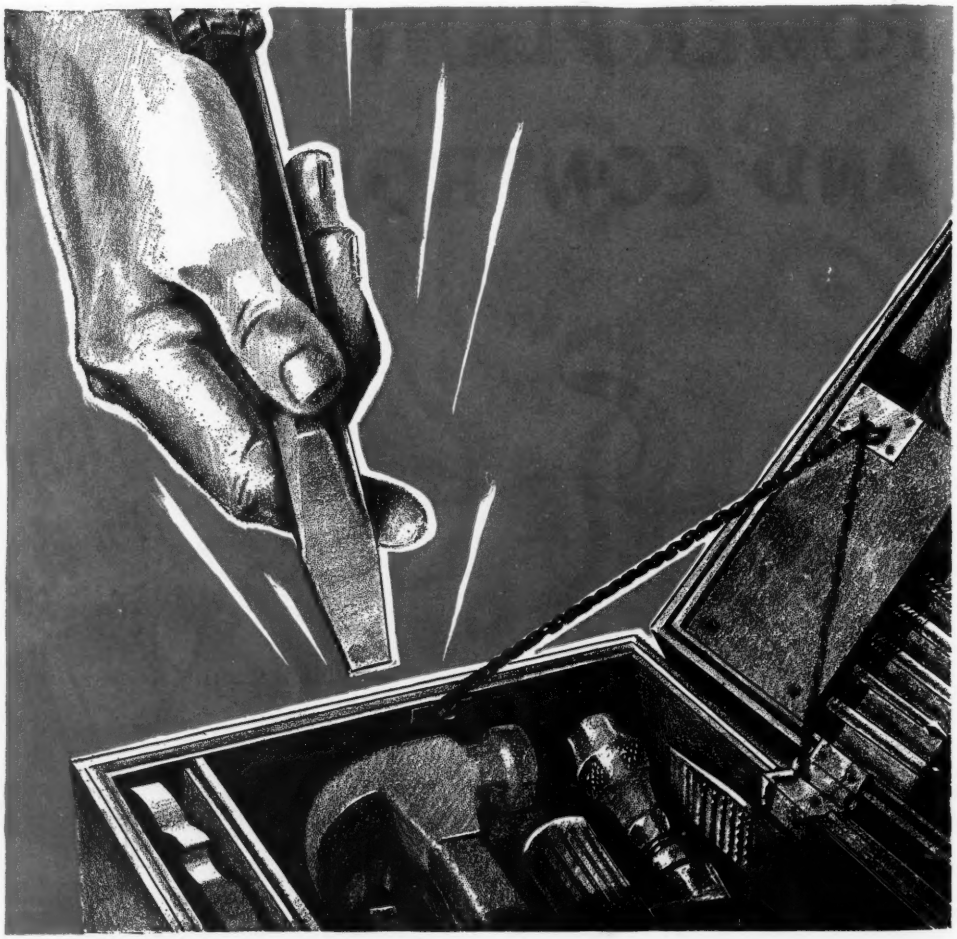
THE REPUBLIC EXHIBIT

POWER PLANT INSTRUMENTS AND CONTROL EQUIPMENT!

At the New York Power Show in Booth No. 6, we will exhibit, for your inspection and examination, the most recent developments in power plant instruments and controls. The exhibit will include Flow Meters . . . CO_2 Meters . . . Draft Gauges . . . Thermometers . . . Automatic Combustion Control Systems . . . Regulators . . . Desuperheaters . . . Valves and other items of interest. Visit Booth No. 6.

REPUBLIC FLOW METERS CO.
2240 DIVERSEY PARKWAY, CHICAGO, ILL.

"WE PUT THE...



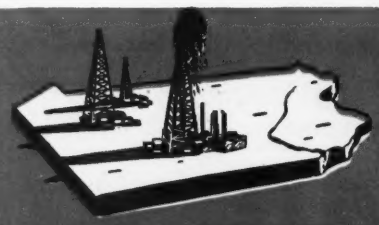
INDUSTRIAL TYCOL OILS-GREASES

TIDE WATER

The Hindenburg, world's largest and only Diesel powered Zeppelin uses

VEEDOL

A Product of the Tide Water Oil Company



100% PARAFFINE BASE CRUDE *assures* HIGHEST FLASH POINT

COLD CHISEL

BACK IN THE TOOL BOX"

"With the Diesel oil we formerly used, so much carbon was produced that finally we had to pound it out with a cold chisel. Then we switched to Tide Water Diesel Oil and we put the chisel back in the tool box. Best of all, our lubricating costs dropped 10 per cent."

Thus one engineer expressed his satisfaction in the economical and trouble-free performance of Tycol Diesel Oil in his engines. Behind this record of satisfaction is Tide Water's 100% paraffine base oil, solvent-refined by the Edeleanu Process. This process provides a Diesel oil which guarantees the greatest operating economy, as all compounds that would tend to oxidize in service have been removed. Free from tarry and asphaltic residues and the unstable, sludge-forming materials that ordinary refining cannot remove, Tycol Diesel Oil assures long, economical service in both stationary and marine Diesels. That is why service records such as the above testify to the economy of using Tide Water Diesel Oil.

A 48-page analysis of lubrication and fuel requirements for Diesels has been prepared for your use. You may have a copy, without obligation, by writing to:

TIDE WATER OIL COMPANY
17 Battery Place, New York, N. Y.

DIESEL OIL

THERE IS A COMPLETE LINE OF TYCOL LUBRICANTS SCIENTIFICALLY ENGINEERED FOR EVERY INDUSTRIAL USE

FLATTEST TEMPERATURE VISCOSITY CURVE
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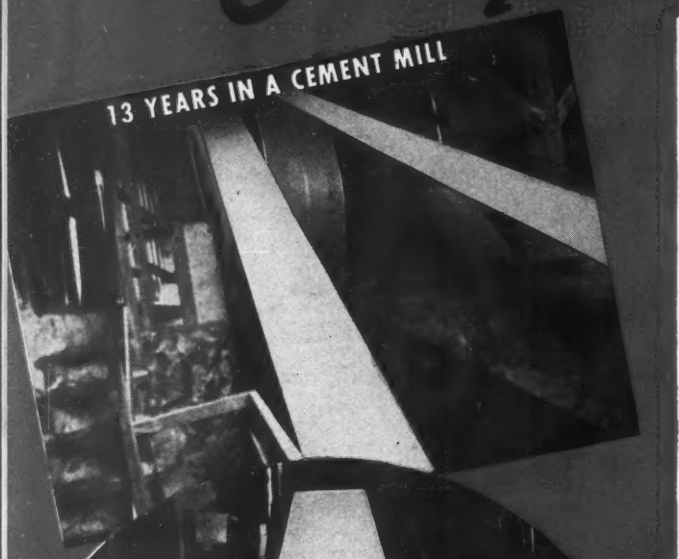
giving
MAXIMUM ECONOMY AND PROTECTION FOR EVERY LUBRICATING DOLLAR

FIT *Every* BELT JOB WITH



Made to Order

LARGE and small—odd sizes, and those easy to fit—U. S. Rubber "tailors" a belt for every type of drive.

Looking around oil fields, mills, and factories, you'll see U. S. Transmission Belts doing big and little jobs *well.* For instance... operating under severe dust conditions in a cement plant a U. S. Rainbow Transmission Belt has given perfect service for 13 years . . . this same Rainbow brand that for 40 years has been meeting requirements of every conceivable type of drive . . . unmatched for sustained performance. In a steel rolling mill 30″ 8-ply U. S. Giant Stitched Rubber Covered Transmission Belt gave 10 years' continuous service, *and was then replaced three years ago with a new U. S. Giant.* On an oil field power drive in Texas a U. S. Royal Cord Cut Edge Endless Belt 187′ 24″, 9-ply, pumps 24 wells. A cotton oil mill is replacing leather belts with 10″, 5-ply Royal Belting, which due to its unusual strength and stamina gives unusual service although practically running in a pile of cotton seed. On light machine drives there is no equal to U. S. Royal Jr. . . . a light, flexible, and elastic belt which permits the use of thick belts for the narrow widths customary to such transmission service, especially when frequent shifting is required.

Get in touch with your nearest U. S. Rubber representative. You may save *dollars* in initial cost—operating cost—replacement cost. Let him *fit your job* with the *right U. S. Transmission Belt.* Write for "An Album of Familiar Belts," containing many interesting transmission application photographs.

United States

United States Rubber Products, Inc.

A U.S. TAILORED BELT!

Fitted to Their Loads

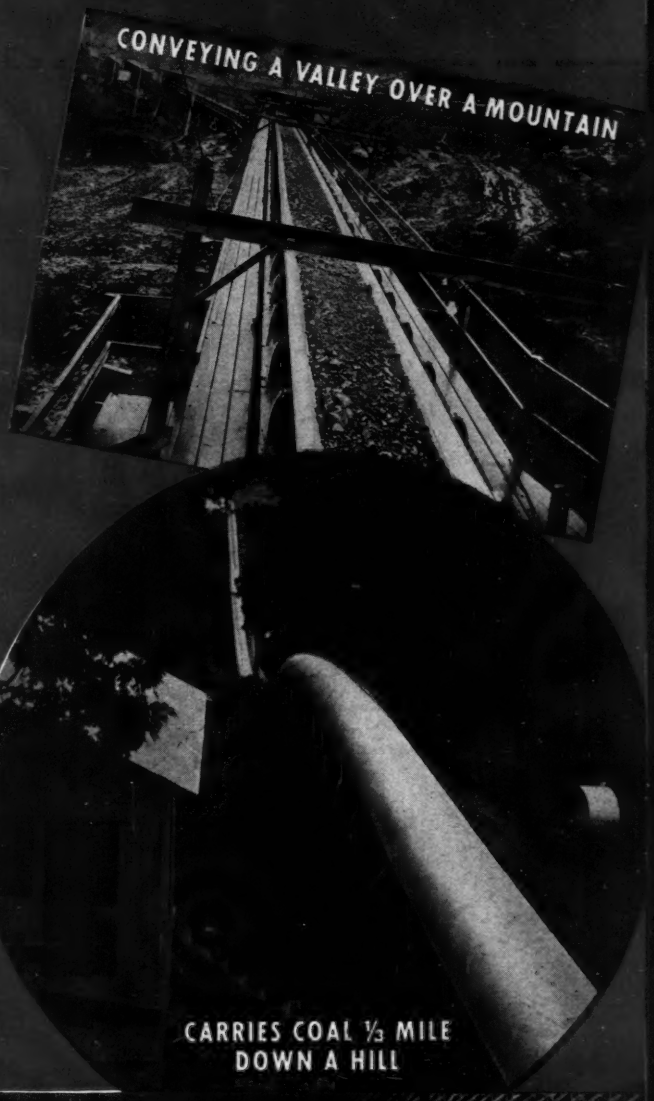
U.S. Conveyor Belts are also tailored to carry their loads fittingly. Go down into a mine . . . or a big excavating job . . . or walk through most any great plant . . . you'll find them hard at work.

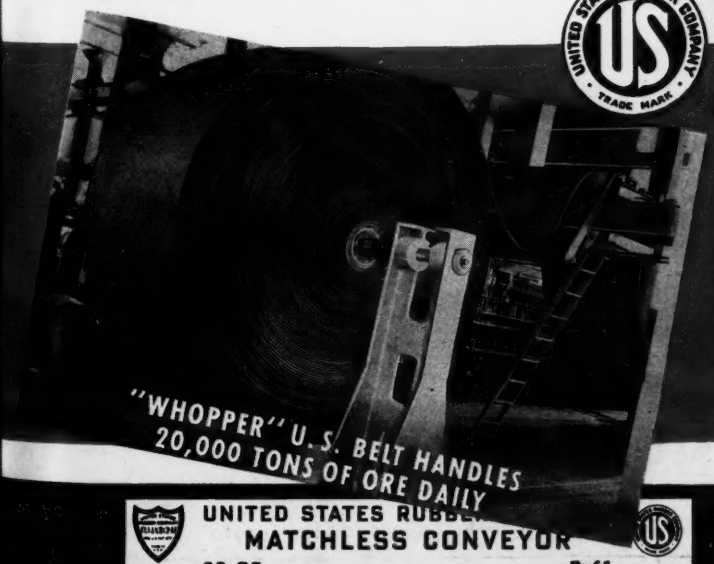
On the Grand Coulee Dam you will see 60" U. S. Matchless Conveyor Belts which have already carried *11,000,000 cubic feet of excavation* from dam site to dump nearly *a mile away,* and almost *400 feet above the river.* On a Pennsylvania hilltop a U. S. Giant Conveyor Belt 1800 feet long lowers run-of-mine coal from the mouth of the mine to tipple. Many other U. S. Conveyor Belts underground in this mine take coal from mine face to surface. In a large limestone plant U. S. Matchless Conveyor Belts especially tailored of 42-ounce duck for exceptional strength to lift 2800 tons an hour, 147 feet, using 500 horsepower. A "whopper" of a belt! 1355 feet of 60", 10-ply U. S. Matchless Conveyor Belt especially "fitted" to do a bigger job for a western mining company. This roll of belt is 11 feet high; weight 15 tons; made under ideal conditions in the huge, well-equipped belt room of U. S. Rubber, Passaic, N. J. Specifications were checked and double checked to insure a "perfect fit" without a repair or blemish. Now in service, it's carrying approximately 20,000 tons of copper ore a day.

These are typical of many installations where U. S. Conveyor Belts are effecting large savings in conveying costs — and carrying their loads efficiently over long periods of time. Use them on *your* job. We will gladly send you, on request, the U. S. Conveyor Belt Album of installation photographs.

Rubber Company

1790 Broadway, New York, N. Y.





UNITED STATES RUBBER COMPANY
MATCHLESS CONVEYOR
32-OZ. P-61

UNITED STATES RUBBER COMPANY
AMAZON CONVEYOR
32-OZ. P-44

UNITED STATES RUBBER COMPANY
GIANT CONVEYOR
32-OZ. P-44

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SECURITY CONVEYOR
28-OZ. P-44

THE MARK OF

"YARWAY EQUIPPED"

YARWAY BLOW-OFF VALVES

Save steam, trouble, money CATALOG NO. B-417

YARWAY WATER COLUMNS AND GAGES

Positive protection against high or low water CAT. NO. WG-1803

YARWAY IMPULSE STEAM TRAPS

Six sizes serve practically all trap needs CAT. NO. T-1720

YARWAY INVOLUTE SPRAY NOZZLES

No internal parts or vanes—Non-clogging CATALOG NO. N-613

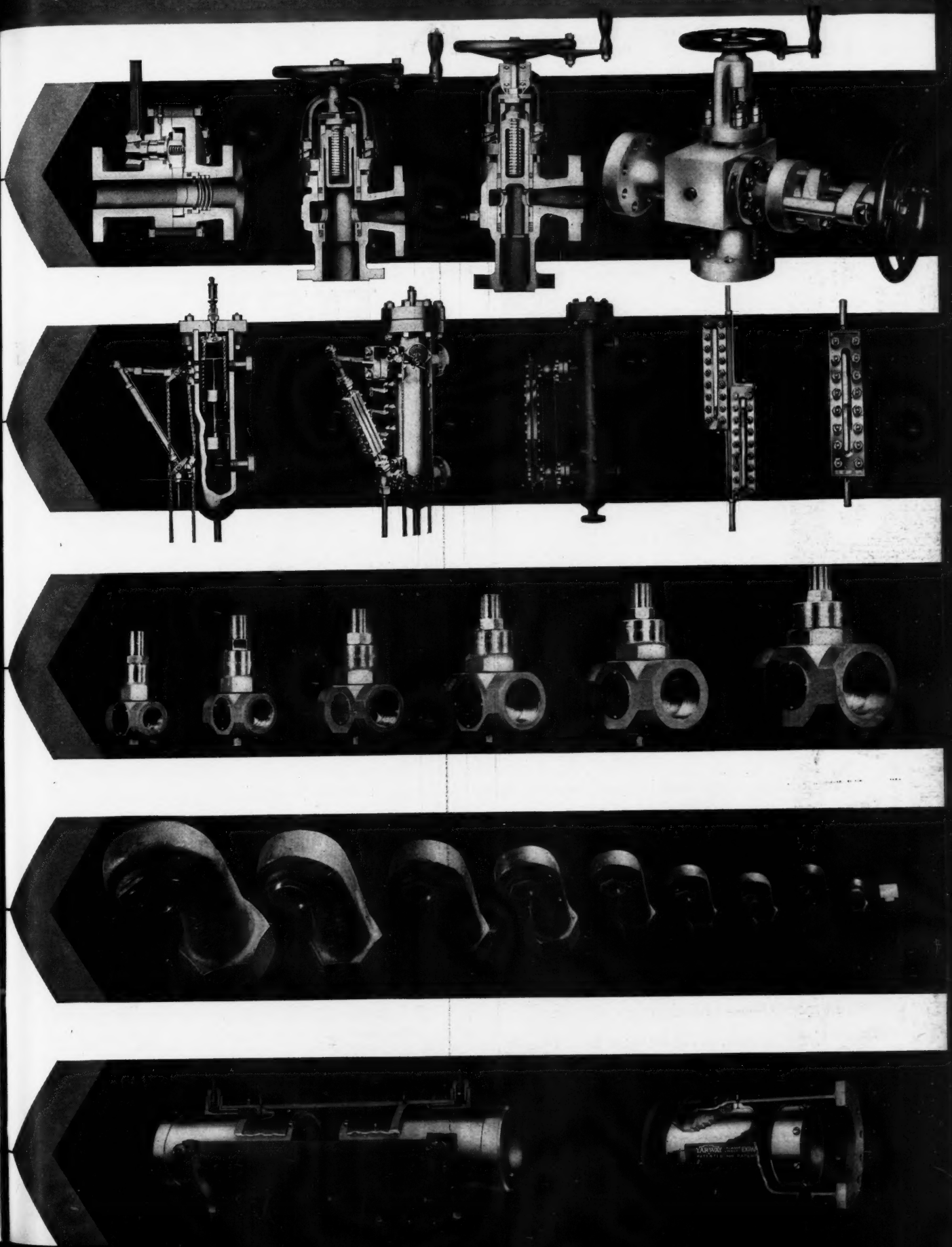
YARWAY EXPANSION JOINTS

Gun pakt and gland pakt types CATALOG NO. EJ-1904

YARNALL WARING CO., MERMAID ST., PHILADELPHIA

See the Yarway Exhibit at the Power Show Booth No. 66

GOOD ENGINEERING



TEXACO AT WORK

Your liners, rings, and bearings remain clean, free from gum and carbon . . . bearing surfaces are protected against premature wear.

You get longer continuous Diesel engine operation with Texaco Algol or Ursa Oils.

These oils are made from special crudes . . . refined by Texaco processes which give them unusual purity and stability, great film strength, and more efficient lubricating qualities.

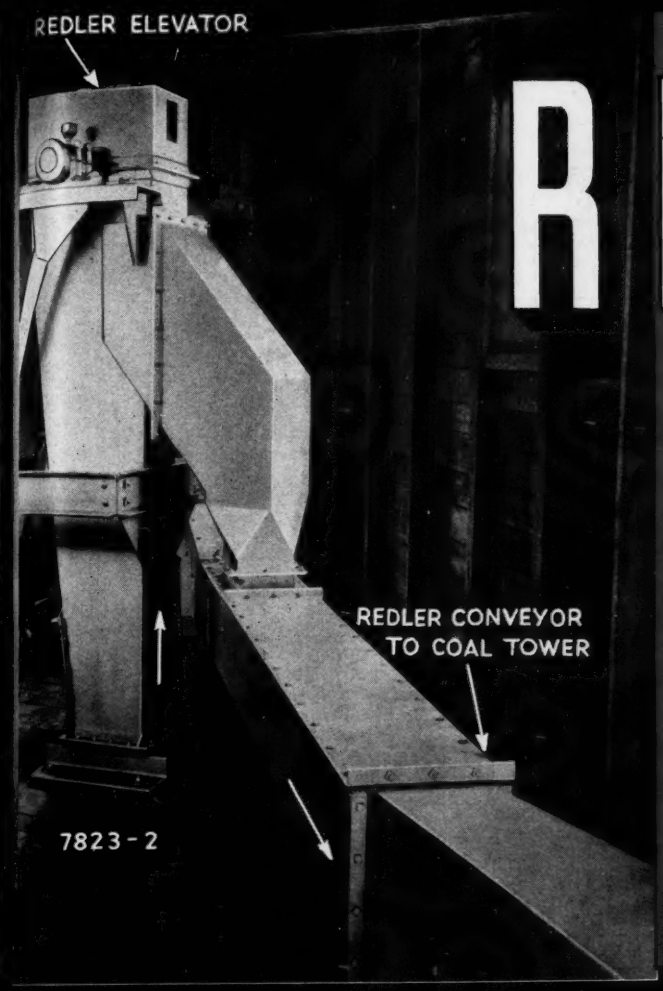
There is a noticeable freedom from blow-by in Texaco lubricated engines. Rings remain active, compression is maintained, fuel is saved. Wear is reduced. What little carbon is formed is soft, fluffy . . . and is blown out of the exhaust.

A Texaco representative will be glad to provide practical engineering service to prove the economies of Texaco Products.

THE TEXAS COMPANY
135 East 42nd St., New York City
Nation-wide distribution facilities assure prompt delivery

TEXACO

TEXACO LUBRICANTS *for all types of Diesels*



REDLER

CONVEYOR-ELEVATORS in the Olson Rug Co. Plant

Using nothing but the latest and best of equipment, the Olson Rug Co. of Chicago has installed Redler conveyors throughout to handle coal in its new power plant. The illustrations show three of the Redler conveyors that help make this new installation one of the show plants of Chicago.

REDLER Conveyors . . . .

Convey with Cleanliness—Coal flows in a solid, undisturbed column through an enclosed casing.

Convey and Elevate—One Redler will often replace two or more ordinary conveyors.

No Breakage—Gentle handling avoids degradation.

Compact—Easy to Install—Erected in less space, in less time than any other type. Smaller track pits.

Low Cost—Simple construction reduces initial conveyor cost, operation and maintenance.

Many Standard Sizes—Built for any capacity up to 250 tons per hour.

Redler Conveyors Handle Coal or any Dry, Free-flowing Pulverized or Granular Bulk Material. Investigate the Many Advantages of the Redler Method.

Write for New Catalog

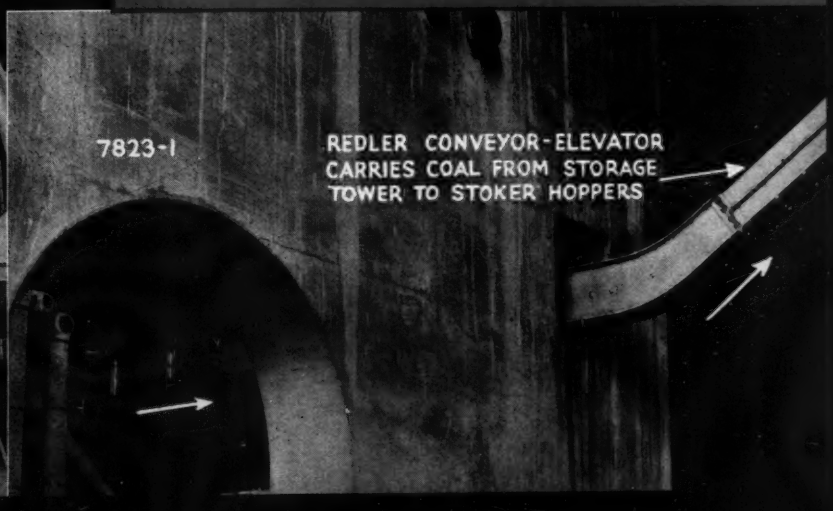
Redler Catalog No. 42 contains complete engineering and installation data

STEPHENS-ADAMSON MFG. CO.

Conveying, Elevating, Screening and Transmission Machinery

515 Ridgeway Ave.

Los Angeles, Calif. AURORA, ILL. Belleville, Ontario



. . back up your judgment when you put in

ARMSTRONG STEAM TRAPS

● For over twenty-five years, Armstrong Traps have been handling the drainage of condensate on jobs of every type. The invariably satisfactory service secured is a matter of record well known throughout the industrial world. This is why more and more heating engineers have standardized on Armstrongs when it comes to traps. By so doing, they know they are placing the stamp of quality on every job. They know there is less chance for future complaints. They know that the Armstrong guarantee of "Complete Satisfaction" means what it says. And they know they can depend on Armstrong representatives for service in any emergency.

• • •

Let us show you what Armstrong Traps and Armstrong Service can mean to you. Call our nearest representative or write.

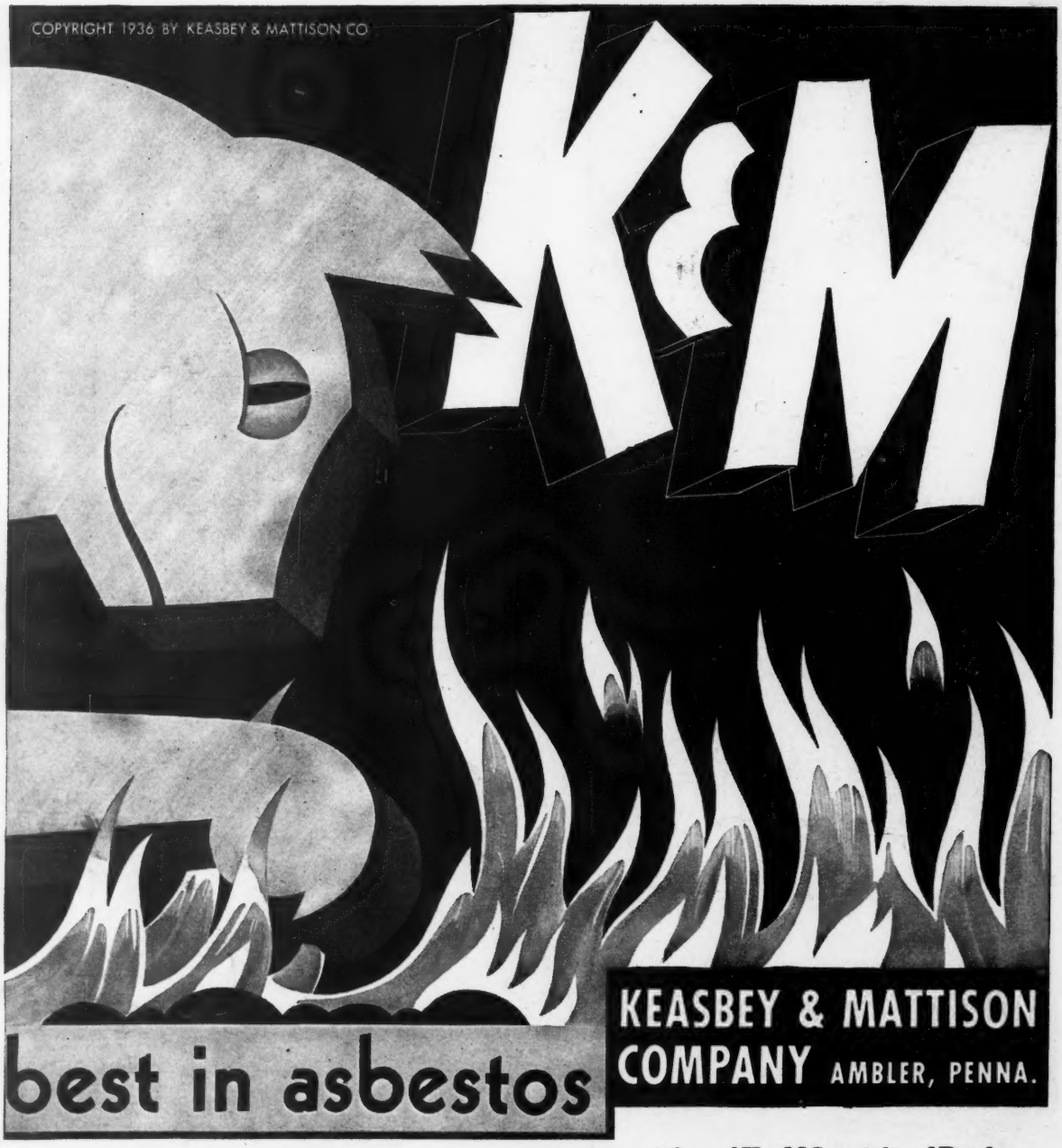
ARMSTRONG MACHINE WORKS

810 Maple Street **Three Rivers, Mich.**

.... ..at -Deepwater

● Today — as for years past — one finds Cameron Centrifugal Pumps serving the modern high pressure boilers in Central Stations and Power Plants. Their reliability and efficiency, their quality, simplicity and economy are not matters of opinion, but of record.

CAMERON



Economy may be your chief reason for using K & M Asbestos and Magnesia products. Their uniformity and durability may appeal most to you. K & M products are the perfected result of a rigid quality-control that starts with the raw asbestos fiber . . . their leadership rests upon more than 60 years spent in the development of insulation materials.

A few of K & M Specialized Products:

"Featherweight" 85% Magnesia Pipe Insulation, Blocks and Lagging
Asbestos Pipe Insulation in sections
Asbestos Insulation in sheets and blocks
Asbestos Insulating Cements
Asbestos Packings: rope, cord and sheet
Asbestos Gaskets, Gasket Tapes and Cloth
Welding Electrodes (Celto)
Refractory Cements, dry and plastic
Asbestos Cement Sheets in corrugated and flat form

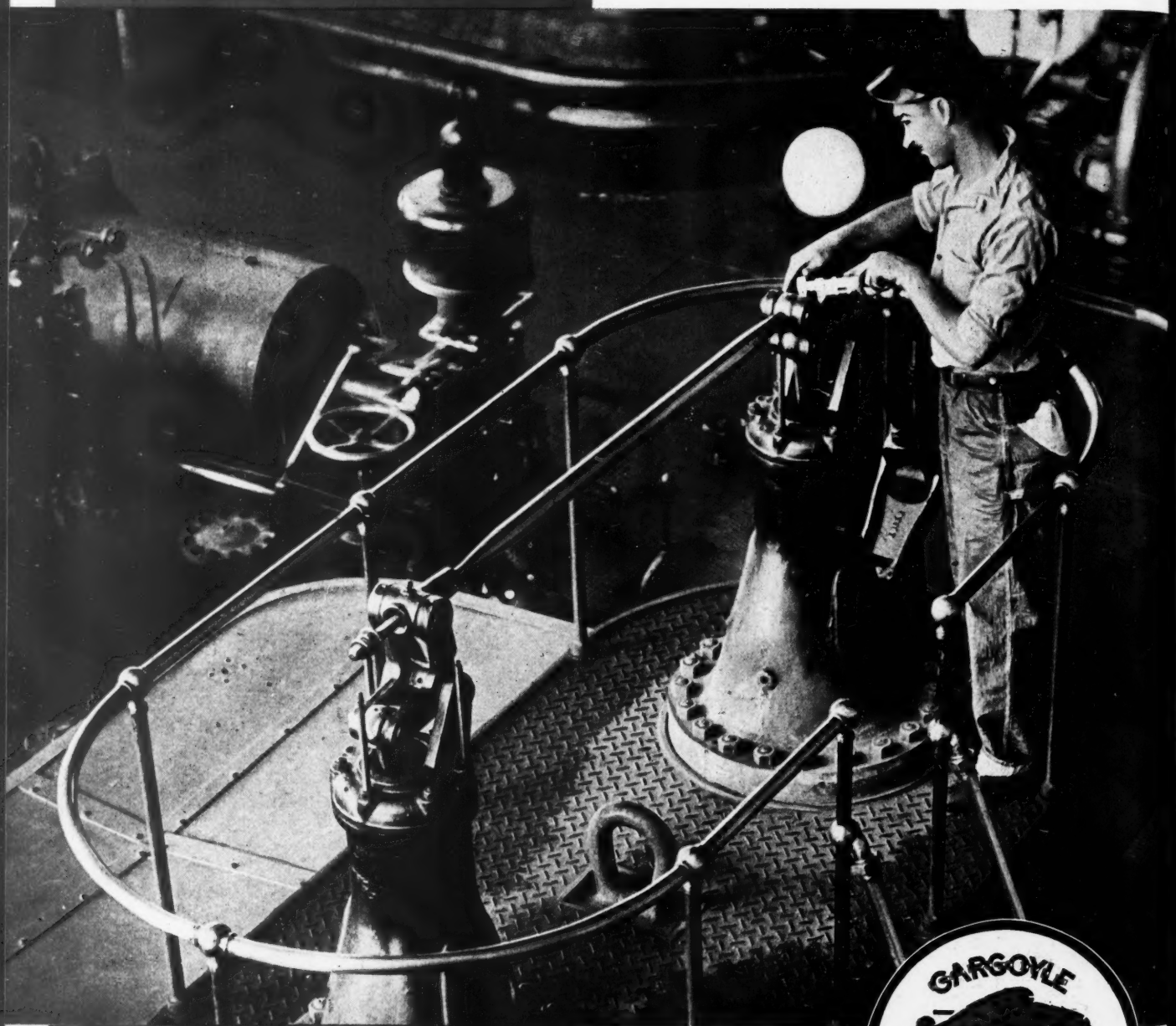
...and Oil for the MINDS IN YOUR PLANT!
SOCONY-VACUUM Will Help Your Men Better the Work they do for You
YOU WILL FIND that your own men—those who know your problems best — will quickly find use in their daily problems for Socony-Vacuum's friendly cooperation and 70 years of practical experience.
Here, a valuable suggestion; there, a new idea, enable them to work out worth-while efficiencies and economies.
That is why thousands of plants—many in your own locality—will tell you one of the best reasons for doing business with Socony-Vacuum is the kind of help their men get. Try this in your plant and see!
SEE THE FOLLOWING PAGE...

BRING DOWN YOUR POWER COSTS!

Save with the right Oils for Generation, Transmission and Production

IN PRACTICALLY EVERY PLANT where Gargoyle Lubricants are in service, performance records show cuts in the cost of power. That is due to their superior lubricating qualities—our experience in using them.

Socony-Vacuum's complete line includes lubricants proved specifically right for generating units, transmission equipment, production machinery. Your men can use our knowledge to help cut your power bill.



GARGOYLE Lubricants

SOCONY-VACUUM OIL Co. INCORPORATED

STANDARD OIL OF NEW YORK DIVISION · WHITE STAR DIVISION · LUBRITE DIVISION · WHITE EAGLE DIVISION
WADHAMS OIL COMPANY · MAGNOLIA PETROLEUM COMPANY · GENERAL PETROLEUM CORPORATION OF CALIFORNIA

For more than 25 years this Company has concentrated its efforts on just one plant problem—the removal of air and water of condensation from all types of steam-heated equipment for both high and low pressure.

Today we offer the largest and most varied line of STEAM TRAPS available. Each one is built exactly to meet the job it has to do. Each one is a leader in its field.

We emphasize thermostatic traps because they are the greatest steam savers. They are also the only traps which cannot air bind and will remove air more quickly and thoroughly than any other type.

But we also make float and bucket traps for use where these are best suited.

Tell us your trap problem and be sure of a permanent solution.

The Sarco line includes also Temperature Regulators for water heaters, kettles, dryers and all steam-heated process equipment; also Water Blenders and Steam and Water Mixers.

For full information ask for Catalog B-5248.

SEE OUR EXHIBIT AT BOOTH NO. 81
Twelfth National Exposition of Power & Mechanical Engineering, Grand Central Palace, New York, Nov. 30 to Dec. 5, 1936.

SARCO CO., INC.

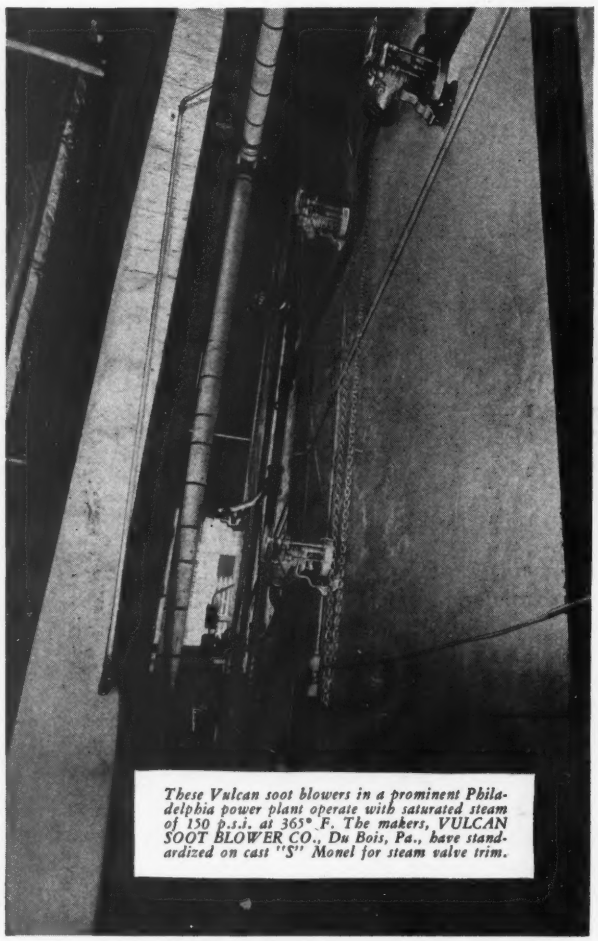
183 Madison Ave., New York, N. Y.

Branches in Principal Cities

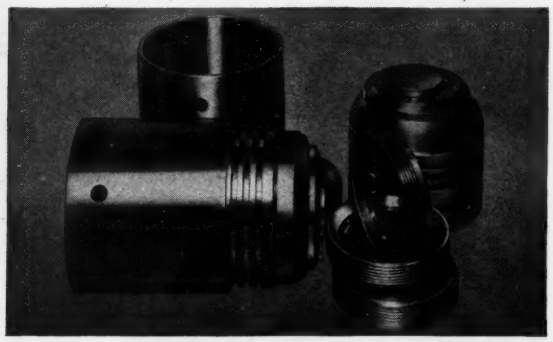
Sarco Canada Ltd., Federal Bldg., Toronto, Ont.

WEAR RESISTANCE

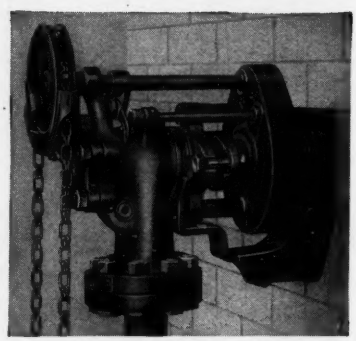
is the EVIDENCE *for valve trim of "S" Monel*



These Vulcan soot blowers in a prominent Philadelphia power plant operate with saturated steam of 150 p.s.i. at 365° F. The makers, VULCAN SOOT BLOWER CO., Du Bois, Pa., have standardized on cast "S" Monel for steam valve trim.



Steam valve trim used in the installation at left. 345 Brinell is the hardness of the "S" Monel piston-type valves and seat rings; piston liners are machined from regular Monel tubing, cold-drawn.



*Valve operating head as made by Vulcan, containing valve trim of cast "S" Monel.**

TAKE stock of your needs in valve trim that has to stand high pressures and high temperatures. Then check over the proved properties you get in castings of "S" Monel. You'll soon see why Vulcan Soot Blower Co., makers of the Soot Blowers shown here, have standardized on this hard WEAR-RESISTING metal.

First, because it's HARD. "S" Monel has all the corrosion resistance of Monel. But adding small amounts of silicon brings its hardness way up to ranges from 275 to 390 Brinell! That means no wire-drawing. In other words . . . long wear.

Although in this particular installation the valves and seat rings operate at only 150 p.s.i. with 365° F. total steam temperature, these same parts have been in perfect service at pressures up to 700 p.s.i. with temperatures of 900° F. That needs *strength*. The tensile strength of "S" Monel is 100,000 to 125,000 p.s.i. Same answer: long wear.

When you add that "S" Monel has a non-galling characteristic invaluable for sliding parts used with other metals . . . you see another prime reason why it fits into their plans. And "S" Monel can be both centrifugally cast in cylinders and sand cast for intricate shapes. Either form can be machined without difficulty.

Engineers who get the facts about "S" Monel's LONG WEAR and the perfect seal it gives, end up by adopting it. Write for full details, addressing:

THE INTERNATIONAL NICKEL COMPANY, INC.

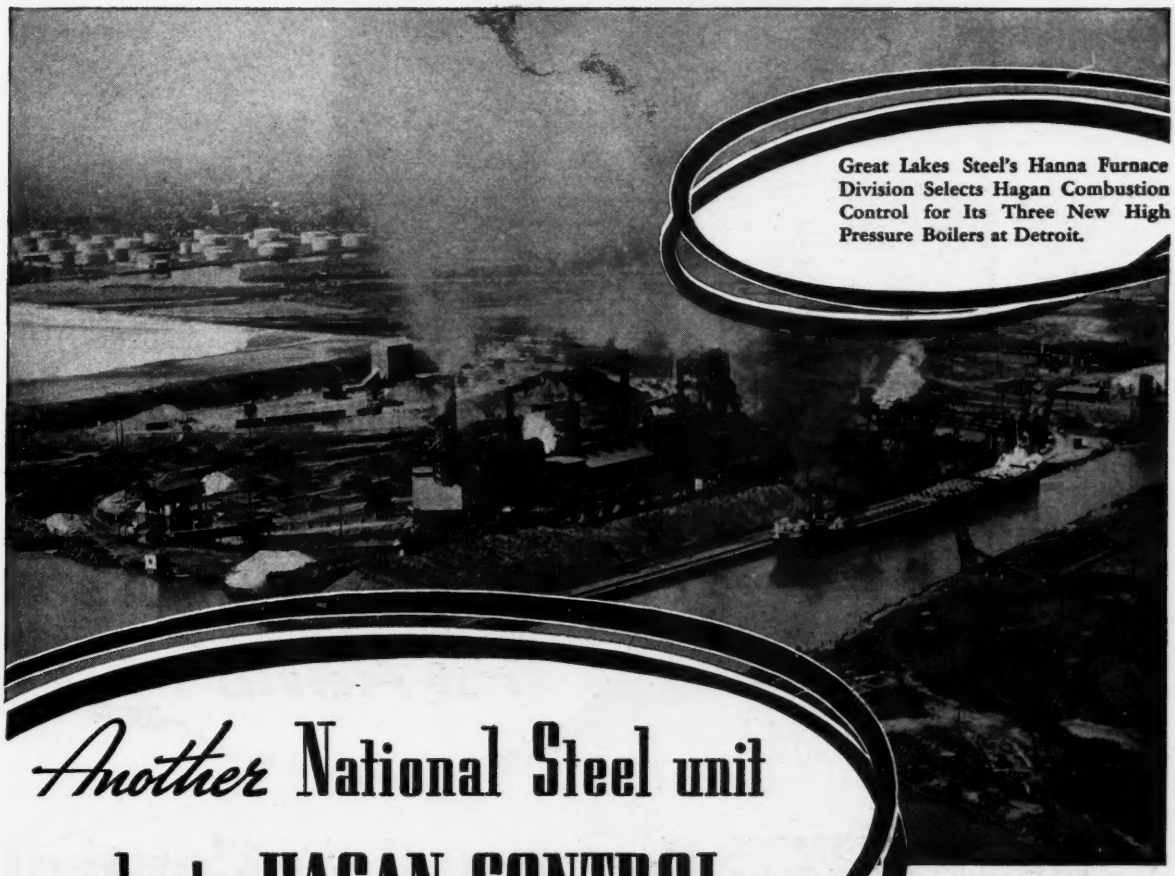
67 WALL STREET NEW YORK, N. Y.

• • •

MONEL

*Trade-mark.

Monel is a registered trade-mark applied to an alloy containing approximately two-thirds Nickel and one-third copper. This alloy is mined, smelted, refined, rolled and marketed solely by International Nickel.



Great Lakes Steel's Hanna Furnace Division Selects Hagan Combustion Control for Its Three New High Pressure Boilers at Detroit.

Another National Steel unit adopts HAGAN CONTROL

Interesting to engineers of the steel industry is the new Hagan Combustion Control system designed for the three new boilers of Hanna Furnace Division, Great Lakes Steel, a unit of National Steel.

These boilers, to operate at 425 pounds pressure and 700° steam temperature, will be fired with blast furnace gas with auxiliary oil firing. Complete automatic air-fuel ratio control is being provided for both blast furnace gas and oil.

The Great Lakes Steel installation by Hagan follows within a few months the installation by Weirton Steel (also a subsidiary of National Steel) of complete Hagan Combustion Control for its two new 400,000 pound boilers at Weirton, West Virginia.

Great Lakes Steel and Weirton Steel of National Steel—Chevrolet and Buick of General Motors—here, within the past six months, are *four of the most important new industrial boiler plant installations in America.*

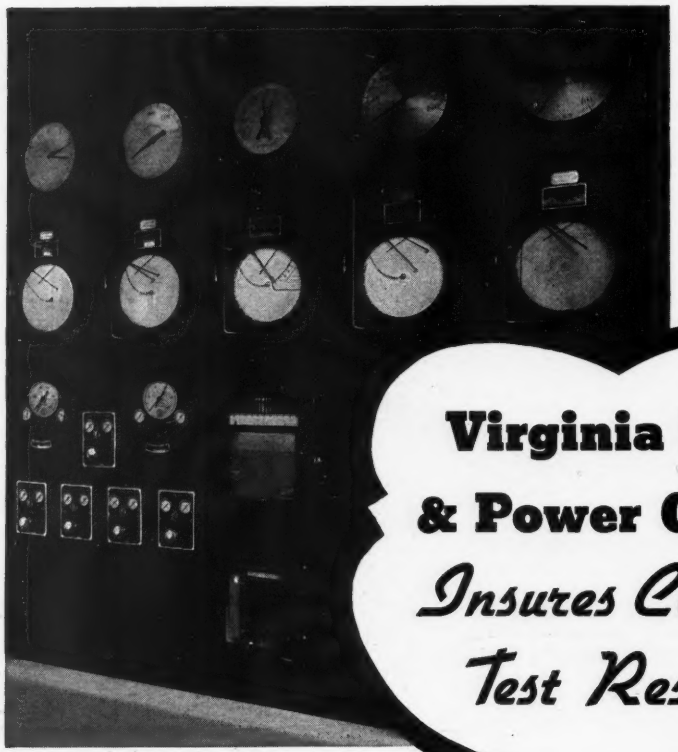
Their selection of Hagan Control indicates recognition of the superiority of Hagan engineering and equipment.

HAGAN

HAGAN CORPORATION

Hall Laboratories Inc., and The Buromin Company, *Associates* Pittsburgh, Pennsylvania

The Pioneer Still Leads



Bailey Meter Control installed at Virginia Electric & Power Company, Richmond, Va.

Virginia Electric & Power Company *Insures Continuous Test Results*

COMPLETE Combustion Control

● Virginia Electric & Power Company has insured continuous test efficiency in the daily operation of its new 450,000 lb. per hr. capacity steam generating unit at Richmond, Virginia, by the installation of complete Bailey Meter Combustion Control.

Test results are secured with Bailey Meter Control because it is COMPLETE. It not only maintains steam pressure, furnace draft and load distribution among boilers, but it also automatically readjusts the fuel or air to continuously maintain maximum combustion economy.

In order to derive the maximum benefit from power plant modernization, be sure that your program includes metering equipment and COMPLETE combustion control.

Write for Bulletin No. 102-A describing complete combustion control.

BAILEY METER CONTROL SYSTEM

BOILER METERS
COMBUSTION CONTROL
MULTI-POINTER GAGES
RECORDERS
FEED WATER CONTROL
SMOKE DENSITY RECORDERS
FLUID METERS

BAILEY METER COMPANY
1040 Ivanhoe Road Cleveland, Ohio
Bailey Meter Company Limited, Montreal, Canada A-21

BAILEY METER CONTROL

The **COMPLETE** *Combustion Control System*

We Improved on "Perfection"!

Not content with enthusiastic reports from users of thousands of Yarway Traps that "it's the best trap we have ever used"—Yarway have carried on their regular program of continuous research, development and refinement to make this trap even better than ever before.

Cadmium-Plated Body, inside and out. We couldn't improve upon the rugged cold-rolled steel bar-stock body for strength and durability—so we improved its finish. Hence the new Yarway Impulse Trap bodies are bright cadmium-plated inside and out, for durable rust-free protection.

Valve and Seat Stainless Steel, heat-treated. We couldn't improve upon the simplicity of "one moving part" design—so we added a bonus of years to its life. Hence the new Yarway Trap valve and seat are stainless steel, heat-treated, to practically eliminate wear.

These refinements have been added to the following revolutionary features that this trap has always offered:

- ***Low price***—often cheaper than repairing other traps.
- ***Light weight***—needs no support.
- ***Small size***—low radiation loss.
- ***Insures quick heating***—will not air-bind.
- ***Operates on exclusive Impulse principle.***
- ***Requires no priming***—it is self-priming.
- ***Easily installed.***
- ***Six sizes***—½ in. to 2 in. for pressures to 400 lbs.
- ***Proven by years of severe service.***

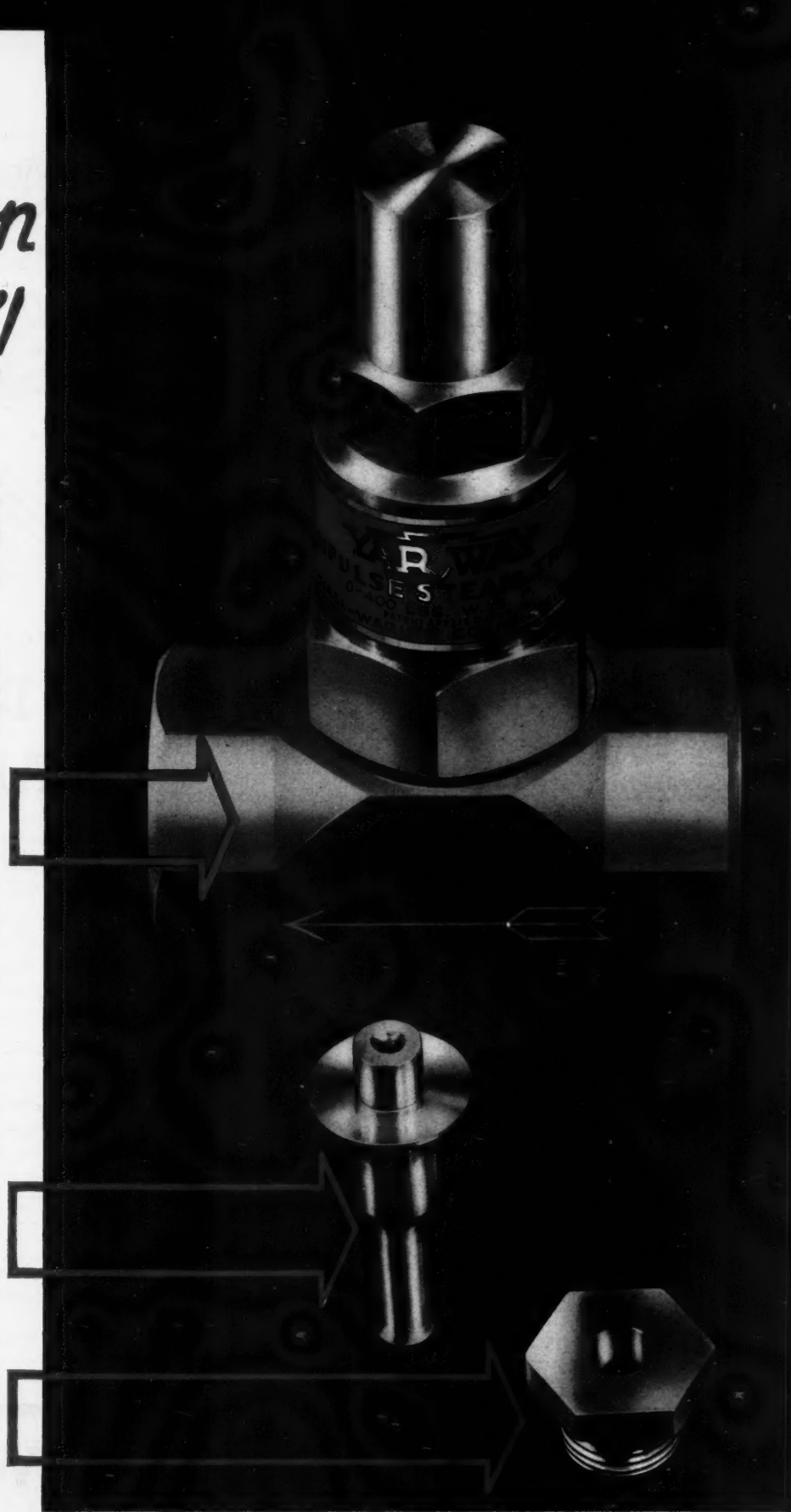
Check these features and you'll recognize a new avenue to Steam Trap Economy for your plant.

Ask your mill supply house or write for Catalog T-1721.

YARNALL-WARING COMPANY
Mermaid Street Philadelphia

See the Yarway Exhibit at the Power Show Booth No. 66

YARWAY



ANOTHER YEAR OF WIDESPREAD POPULARITY

IMPULSE STEAM TRAP

Impulse Principle Explained: *If you are interested in the complete thermo-dynamic explanation of this trap's operation—write for your copy of a paper recently presented before the American Society of Mechanical Engineers and published in the August 1936 issue of Mechanical Engineering Magazine. Sent on request.*

FLOW TOTALS AT A GLANCE

FOXBORO DOES YOUR CALCULATING

Forget your mathematics! Foxboro Integrating Flow Meters enable you to read total flow directly. It's as easy as reading mileage on a speedometer. You get the answer directly in cubic feet, pounds, gallons or any other flow quantity. This feature is available in the entire range of Foxboro Flow Meters.

To correct errors due to line pressure fluctuations, any Foxboro Meter may be equipped with an automatic Pressure Compensator. Both records and integrator readings are compensated. The Foxboro reading is accurate even under most adverse conditions.

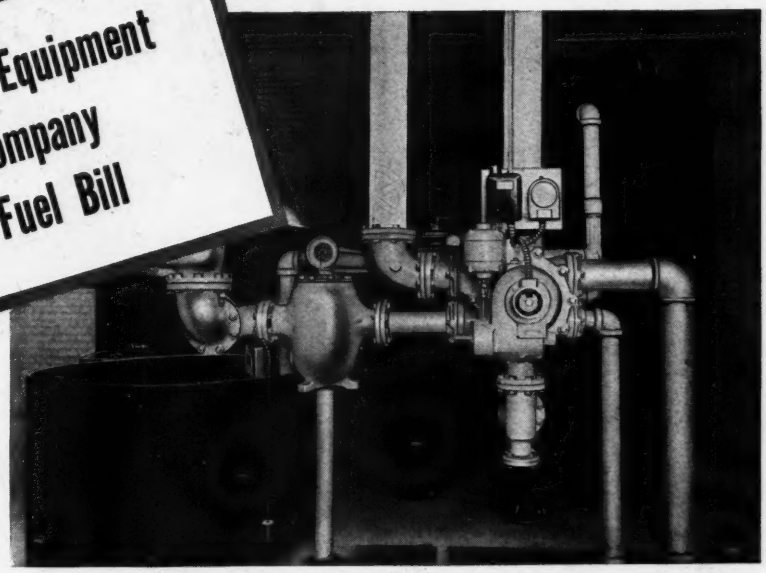
Bulletin 200-1 and Folder 692 give full details. Write for copies.

THE FOXBORO COMPANY
70 Neponset Avenue, Foxboro, Mass., U.S.A.
Branches in 25 Principal Cities

FOXBORO FLOW METERS

ACCURACY FOXBORO RESPONSE

Water Conditioning Equipment Saved This Company 25% of Its Fuel Bill



Equipment such as this eliminates all hard-water troubles

THIS letter is typical of hundreds we have received from companies who installed Permutit Water Conditioning Equipment and r e d u c e d operating c o s t s enough to pay back the entire cost of the equipment, usually within two years.

"We installed a Permutit Water Softener in our plant fourteen months ago, and have found it satisfactory and economical. It has enabled us to run our boilers for as long as three months without shutting them down for cleaning. Prior to that time, we could not operate them longer than three weeks on account of scale formation in the boilers, feed-water line, and feed-water heater.

"Our feed-water heater formerly was cleaned every three months; and since we have installed the softener, we have only cleaned it once in fourteen months.

"We estimate that we have saved about 25% on our boiler fuel bill since installing the softener."

No wonder there are nearly 10,000 power plants in more than 400 separate American industries that use and recommend Permutit equipment . . . large plants, small plants, plants operating in hard-water districts, plants located where boiler feed-water is relatively soft. And they ALL save money on operating expenses.

It costs you nothing to investigate Permutit and find out if your plant can make these savings, too. If you wish, you can finance the purchase under FHA terms. Mail the coupon below for complete descriptive literature on the type of equipment you are interested in. There is no obligation.

MODERNIZE ★ ECONOMIZE ★ PERMUTIZE ★

Permutit

Water Conditioning

Permutit Water Conditioning Equipment may now be purchased under the terms of the National Housing Act. These loans are not made by the Government, but by your own banker . . . or they can be arranged through Permutit. The terms of payment allow gradual liquidation over a period of years, so your payments are more than met by the savings effected by Permutit.

Permutit makes equipment for removing hardness from water, equipment for removing other soluble impurities from water, pressure and gravity filters for removing suspended impurities from water, equipment for feeding chemicals to water, continuous blowoff systems, heat exchangers, and Ranarex Mechanical Type CO_2 Indicators and Recorders.

THE PERMUTIT COMPANY, Dept. A1, 330 W. 42nd St., New York City.
Please send me, without obligation, complete details about the Permutit Equipment and its purchase under the terms of the National Housing Act. I am particularly interested in the following Permutit products:

.....

Name .....

Position .....

Company .....

Address..... City.....

What USERS *say about...*

Detroit Multiple

"Over 80% average efficiency - an every day experience."

"My experience with Detroit Stokers has been very pleasing from a mechanical standpoint".

"We carry 200% rating with Illinois screenings very satisfactorily."

"Saved 362 tons of coal the first three months of operation."

"Economy of coal, instantaneous response to sudden demands are reasons for repeat orders."

"The sliding movement of the retort bottoms is adjustable and maintains an even fuel bed."

"It handles our light load periods satisfactorily.

"The individual adjustment of plunger ... that increases and decreases the quantity of coal to any one retort is, we feel..

"We are able to control, accurately, the quantity of coal and air supplied to various parts of the fuel bed."

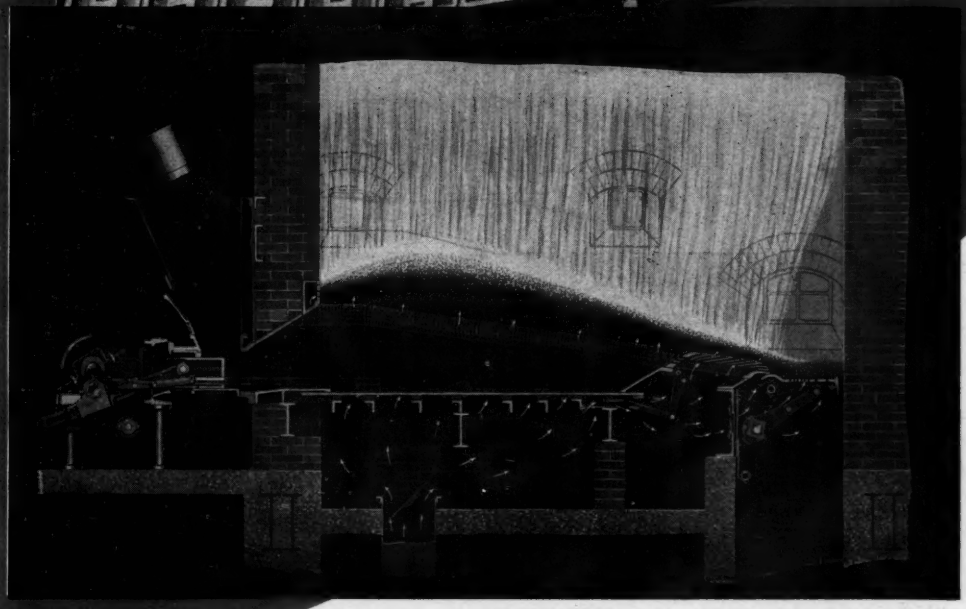
"Our last three Stoker purchases are Detroit - very satisfactory, . . . continuous service . . . 250% of rating."

"Closely spaced retorts mean better air distribution."

"Our daily efficiencies run from 78% to 80%.

Retort Stokers

● Detroit Multiple Retort Stoker showing inclined tuyeres, square runs and rugged construction.



● Sectional side elevation of Detroit Stoker showing inclined fuel bed with complete underfeed action, correct air distribution by zones and easy adjustment of coal feed and distribution.

MODERNIZE AND ECONOMIZE WITH

DETROIT SINCE 1898 STOKERS

WRITE for BULLETIN 124

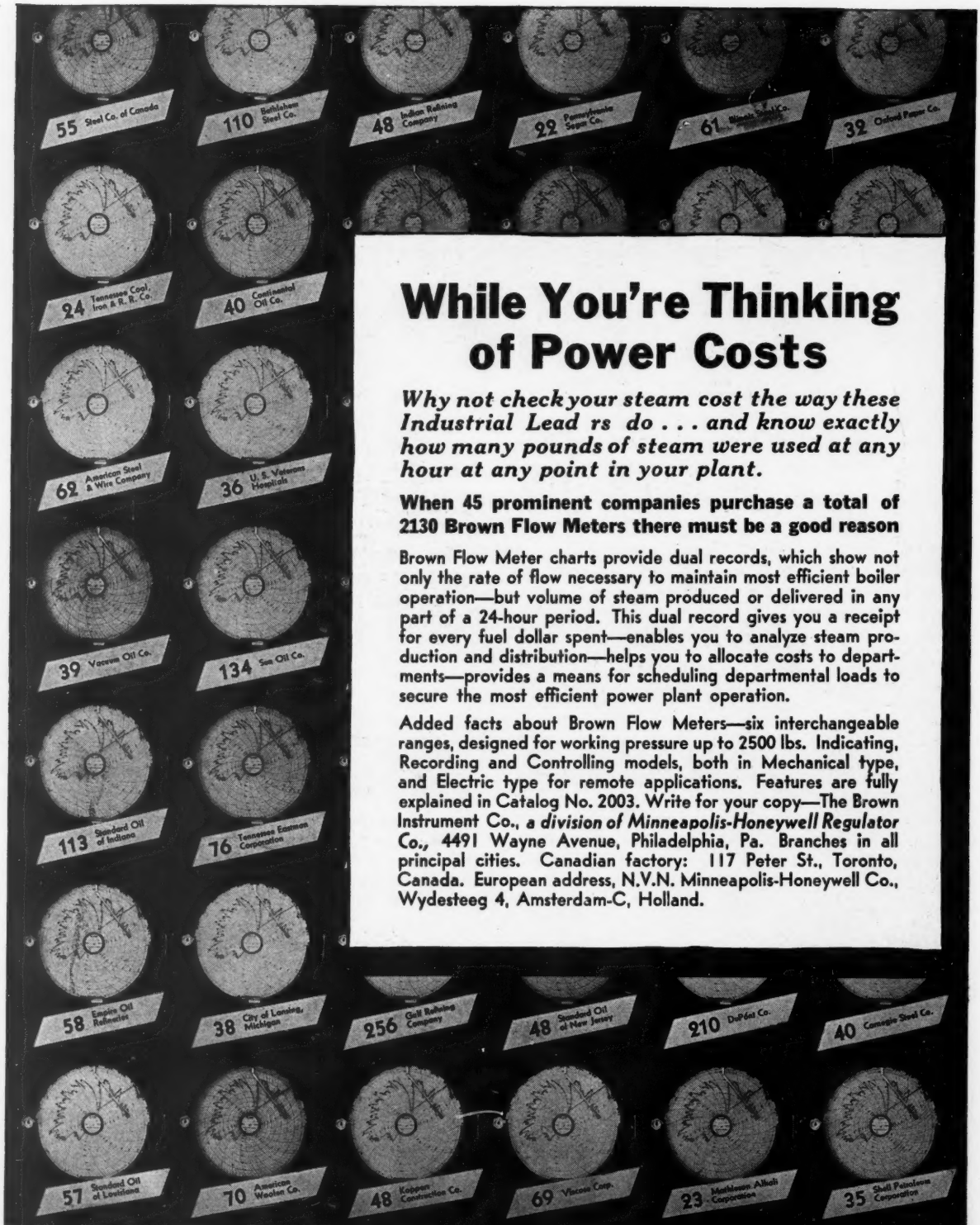
DETROIT STOKER COMPANY

Sales and Engineering Offices:

Fifth Floor, General Motors Building, Detroit, Michigan

Works at Monroe, Michigan . . . District Offices in Principal Cities

BUILT IN CANADA AT LONDON, ONTARIO


55 Steel Co. of Canada
110 Bethlehem Steel Co.
48 Indian Refining Company
22 Pennsylvania Sugar Co.
61
32 Oxford Paper Co.
24 Tennessee Coal, Iron & R. R. Co.
40 Continental Oil Co.
62 American Steel & Wire Company
36 U. S. Veterans Hospitals
39 Vacuum Oil Co.
134 Sun Oil Co.
113 Standard Oil of Indiana
76 Tennessee Eastman Corporation
58 Empire Oil Refineries
38 City of Lansing, Michigan
256 Shell Refining Company
48 Standard Oil of New Jersey
210 DuPont Co.
40 Carnegie Steel Co.
57 Standard Oil of Louisiana
70 American Woolen Co.
48 Koppers Construction Co.
69 Viscose Corp.
23 Mathieson Alkali Corporation
35 Shell Petroleum Corporation

While You're Thinking of Power Costs

Why not check your steam cost the way these Industrial Lead rs do . . . and know exactly how many pounds of steam were used at any hour at any point in your plant.

When 45 prominent companies purchase a total of 2130 Brown Flow Meters there must be a good reason

Brown Flow Meter charts provide dual records, which show not only the rate of flow necessary to maintain most efficient boiler operation—but volume of steam produced or delivered in any part of a 24-hour period. This dual record gives you a receipt for every fuel dollar spent—enables you to analyze steam production and distribution—helps you to allocate costs to departments—provides a means for scheduling departmental loads to secure the most efficient power plant operation.

Added facts about Brown Flow Meters—six interchangeable ranges, designed for working pressure up to 2500 lbs. Indicating, Recording and Controlling models, both in Mechanical type, and Electric type for remote applications. Features are fully explained in Catalog No. 2003. Write for your copy—The Brown Instrument Co., *a division of Minneapolis-Honeywell Regulator Co.,* 4491 Wayne Avenue, Philadelphia, Pa. Branches in all principal cities. Canadian factory: 117 Peter St., Toronto, Canada. European address, N.V.N. Minneapolis-Honeywell Co., Wydesteeg 4, Amsterdam-C, Holland.

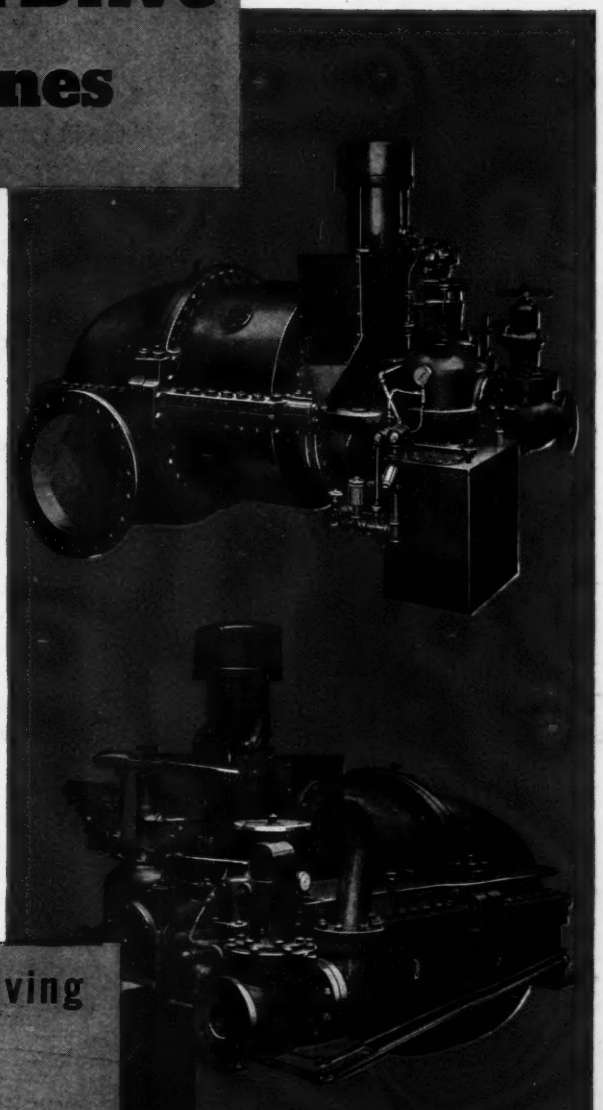
BROWN FLOW METERS

AND

MINNEAPOLIS-HONEYWELL CONTROL SYSTEMS

Electrical and Mechanical

Save Money with G-E Mechanical Drive Steam Turbines



These Multistage Turbines Give High Efficiency with Minimum Maintenance

BECAUSE—

MULTISTAGING enables the turbine to transform into useful work the maximum amount of energy available in the steam.

MIXED-PRESSURE OPERATION of these turbines makes it possible to obtain power from low-pressure steam heretofore not used. The steam is admitted to an intermediate stage and then passes through the last stages—this improves plant efficiency and reduces fuel cost.

EXTRACTION STEAM for process or heating is supplied from an intermediate stage of the turbine when the turbine is equipped with the extraction feature. As no internal lubrication is used, the extracted steam is clean—and a clean heating system saves fuel.

LOW COSTS for repairs and replacements result from the use of few moving parts. A completely enclosed and well-designed lubrication system keeps wear at the minimum. Careful design and manufacture give you a turbine which will stand up under the most exacting service.

There is a G-E turbine for your requirements, in any size and horsepower rating. Let the nearest G-E turbine specialist help you choose turbines; or, call the nearest G-E sales office for information. If you do not have literature further describing our mechanical-drive turbines, write us for it. General Electric, Schenectady, New York.

Type DS 40,000-to-80,000-hp.

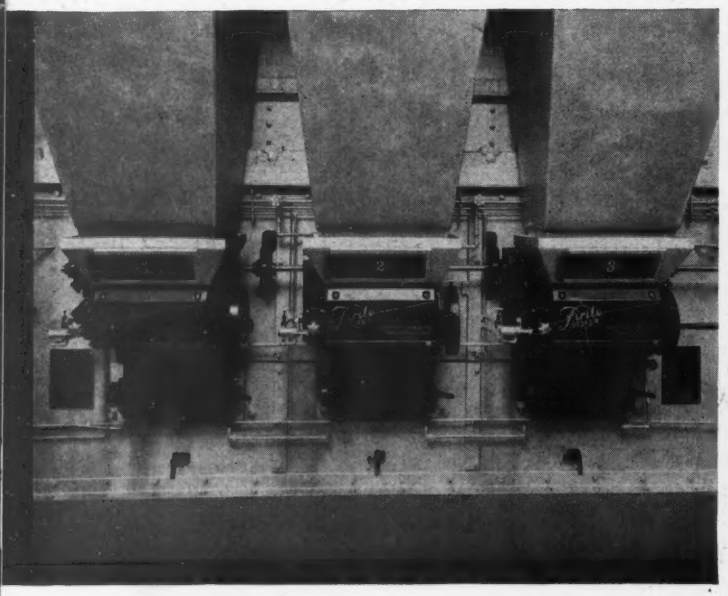
For Driving

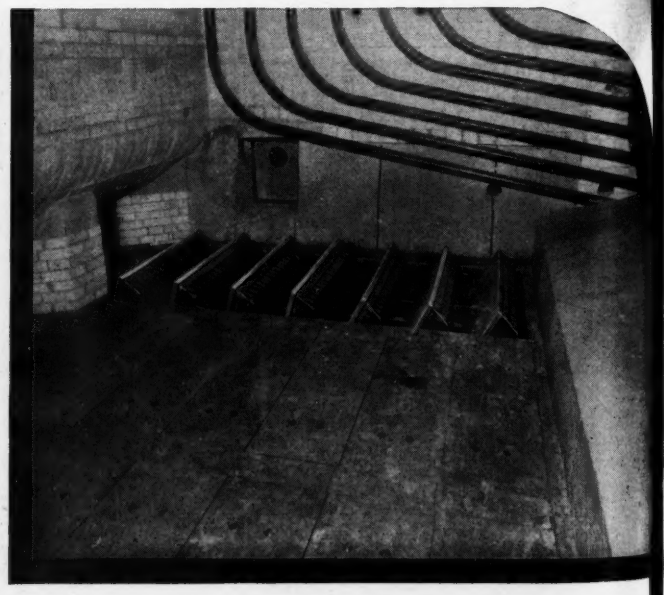
- PUMPS
- FANS
- COMPRESSORS
- BLOWERS
- LINE SHAFTS
- PULVERIZERS

GENERAL ELECTRIC

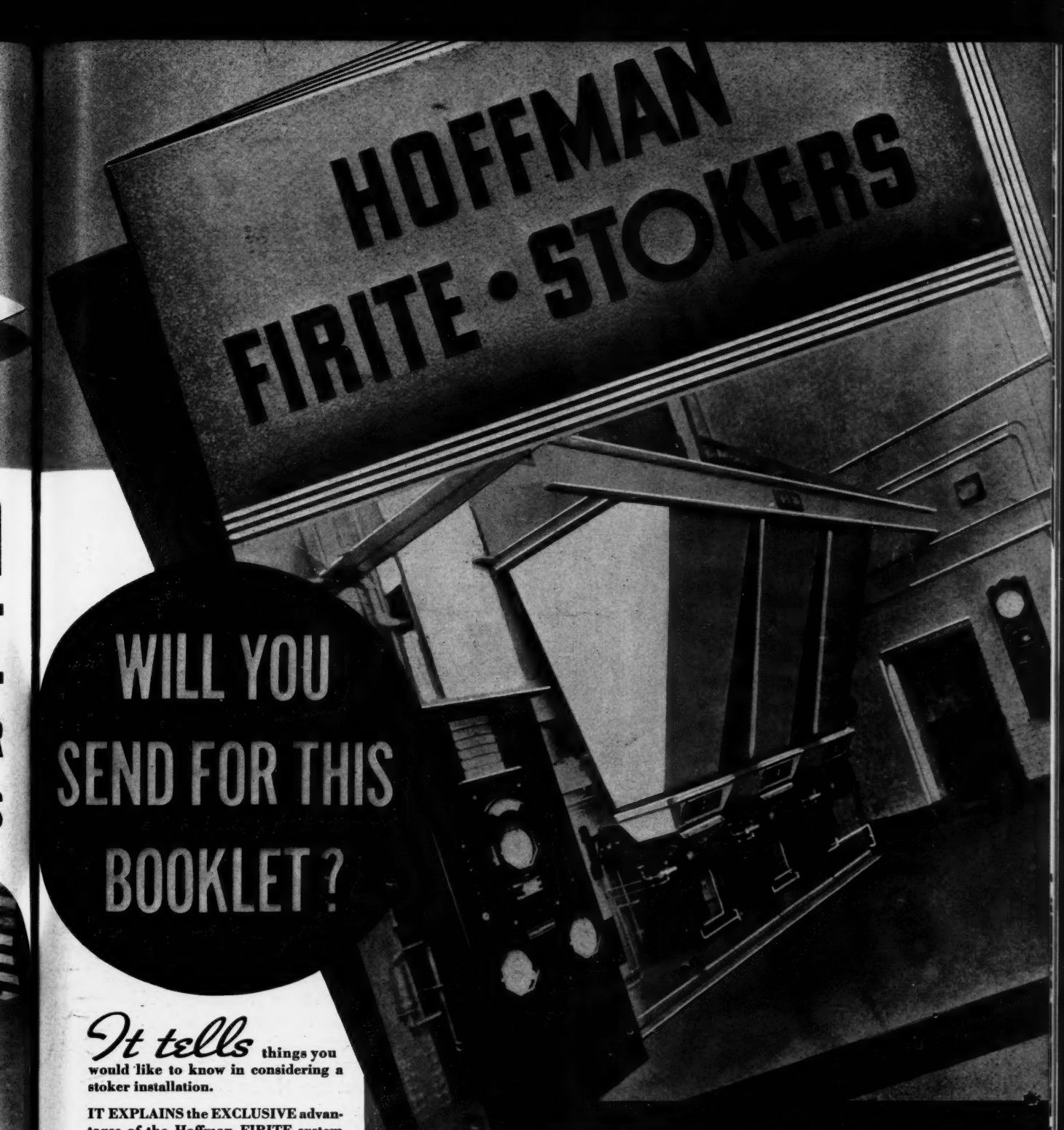
CONSECUTIVE YEARS HOFFMAN FIRITE STOKERS HAVE OUTSOLD

ANY OTHER STOKER EQUIPMENT FOR HIGH PRESSURE WATER TUBE BOILERS





HOFFMAN COMBUSTION ENGINEERING C



WILL YOU SEND FOR THIS BOOKLET?

It tells things you would like to know in considering a stoker installation.

IT EXPLAINS the EXCLUSIVE advantages of the Hoffman FIRITE system — continuous light firing with even distribution of fuel—thin, uniform fuel bed—98% of forced draft used for combustion goes through the fuel bed.

IT ILLUSTRATES the wide range of application in boilers of various types and sizes, from 60 Hp. up to 100,000 lb. steam generators and larger.

COMPANY DETROIT MICHIGAN

HOFFMAN COMBUSTION ENGINEERING CO.
FORD BLDG., DETROIT, MICHIGAN

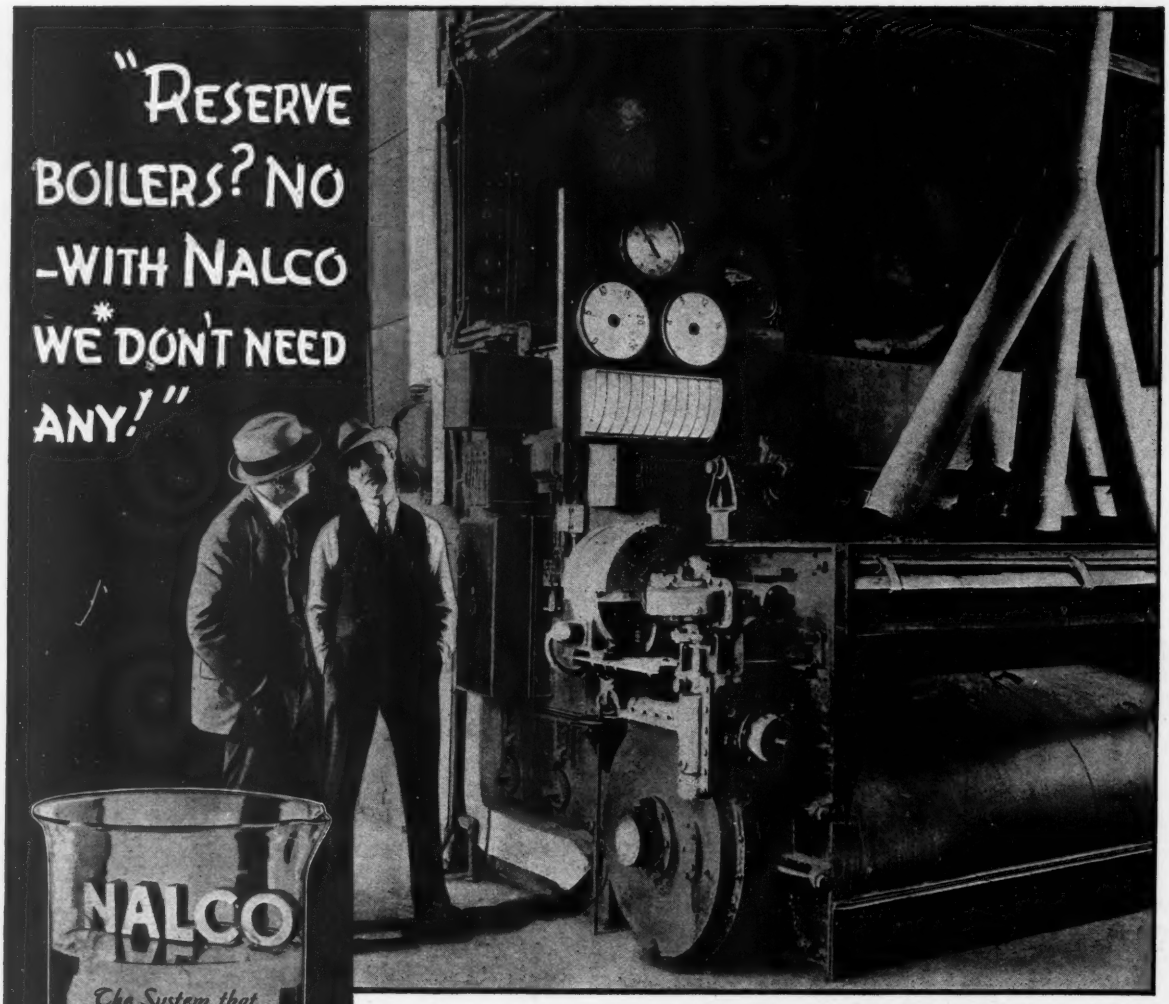
Thank you. I'd like a booklet.

*Name*_____

*Company*_____

*Address*_____

"RESERVE BOILERS? NO -WITH NALCO WE DON'T NEED ANY!"*



*This is a large utility company. Following is an unexpurgated statement from the report made by the Nalco field engineer on this job: "They recently took a boiler off after running it four months full blast and it had no scale in it, but only a deposit which could have been brushed off, they put it right back on the line without doing a darn thing on it as far as evaporating surfaces were concerned. This plant now runs all their boilers all the time and if there are any repairs they do it on Sundays."

IS the engineer quoted above boasting a bit? Not at all—he is merely voicing the confidence that power plant engineers get after they become regular users of the Nalco System of Feedwater Treatment. That he was so confident as to do without reserve boilers is, of course, a practice not recommended for general policy. But even with good practice continuing to call for ample provisions against emergencies, we believe you will still find plenty about the Nalco System to make you equally enthusiastic.

Adoption of the Nalco System requires no additional capital investment. Total cost is often less than your present expenditures for chemicals alone. Have one of our field engineers make a survey of your requirements. No obligation.

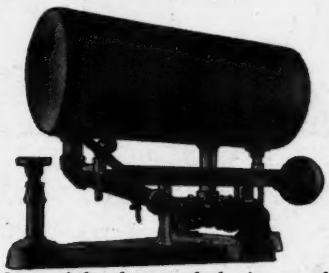
NATIONAL ALUMINATE CORPORATION

6224 W. 66th Place **Chicago, Illinois**

Foreign inquiries, *excepting those from U. S. Possessions, Canada and Mexico*, should be addressed to ALFLOC LTD., Bush House, Aldwych, London, W. C. 2, England. Canadian inquiries should be sent to ALUMINATE CHEMICALS, LTD., 372 Bay Street, Toronto, Ontario.

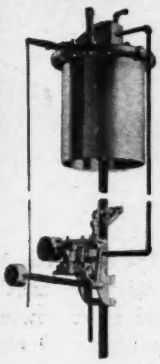
MOREHEAD does it Best!

Morehead BACK-TO-BOILER SYSTEM



Provides quick, thorough drainage of steam-heated apparatus . . . automatic return of all condensate to boilers at original high temperatures. Lowers maintenance cost, speeds production, assures substantial savings in steam and fuel.

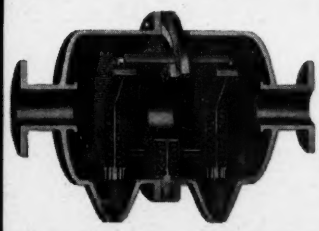
Morehead MIDGET BOILER FEEDER



Amazing new direct pressure boiler feeder for boilers up to 10 h.p. —operates on boiler pressure steam up to 125 pounds. "Remote Control" feature keeps all of the valve mechanism easily accessible from the floor. No floats, no tilting, no adjustments, no outside power necessary. Easy to install . . . no maintenance expense.

Morehead EXHAUSTEAM PURIFIER

Combines all steam-cleansing principles in a single, compact unit, assuring *complete* purification. Delivers clean, dry exhaust steam that may be safely substituted for live steam for heating, drying, cooking and processing at a sharp reduction in fuel costs. Also yields a pure, distilled, soft condensate ideal for boiler feeding and other purposes at additional savings.



Morehead MAKE-UP WATER REGULATOR

Automatically provides make-up water for small boilers—requires no attention . . . no maintenance expense. Simple design and construction assure trouble-free performance. Safe—prevents flooding or scorching of boiler. The last word in convenience and efficiency.

Morehead products are the result of more than forty years of practical experience in the steam specialty field. Thousands of plant owners all over the world are enjoying the benefits and profits of Morehead equipment. Take the first important step toward greater efficiency and more profit in *your* plant . . . check and mail the coupon TODAY!

MOREHEAD MANUFACTURING CO.

DETROIT, MICHIGAN

MOREHEAD MANUFACTURING COMPANY
DEPT. PP **DETROIT, MICHIGAN**

I want to cut fuel costs, increase efficiency, show greater profit. Without obligation, mail me details on units checked below.

☐ Back-to-Boiler System ☐ Midget Boiler Feeder

☐ Exhausteam Purifier ☐ Make-Up Water Regulator

Name _____

Address _____

City _____ State _____

Although it is not always easy to detect the wastage, inefficient "White Elephant" boilers, engines, pumps and other power units may be tossing away up to 50 cents of every dollar expended for power service.

Which units are profit-eating "White Elephants" — How much can be saved by modern combustion methods? — How can we get inexpensive by-product steam for heating and process work? Will it be most economical to generate all our own power to buy some of it? These are some of the questions with which you may be faced. Why not present your management with facts and figures. Austin Engineers will gladly cooperate with you.

The Mechanical Division of The Austin Company is able by training and experience to analyze, design, construct and install practically every type of power facility. An inquiry involves no obligation. Your nearest Austin office will be glad to serve you.

MORE PROFIT DOLLARS
"A power dollar saved is a profit dollar earned." A new and modern power plant is the one way to eliminate ALL power waste. Such facilities will pay for themselves in a surprisingly short time.
THE AUSTIN COMPANY
ENGINEERS AND BUILDERS · 16112 Euclid Ave. · Cleveland, Ohio · Telephone GLenville 5400
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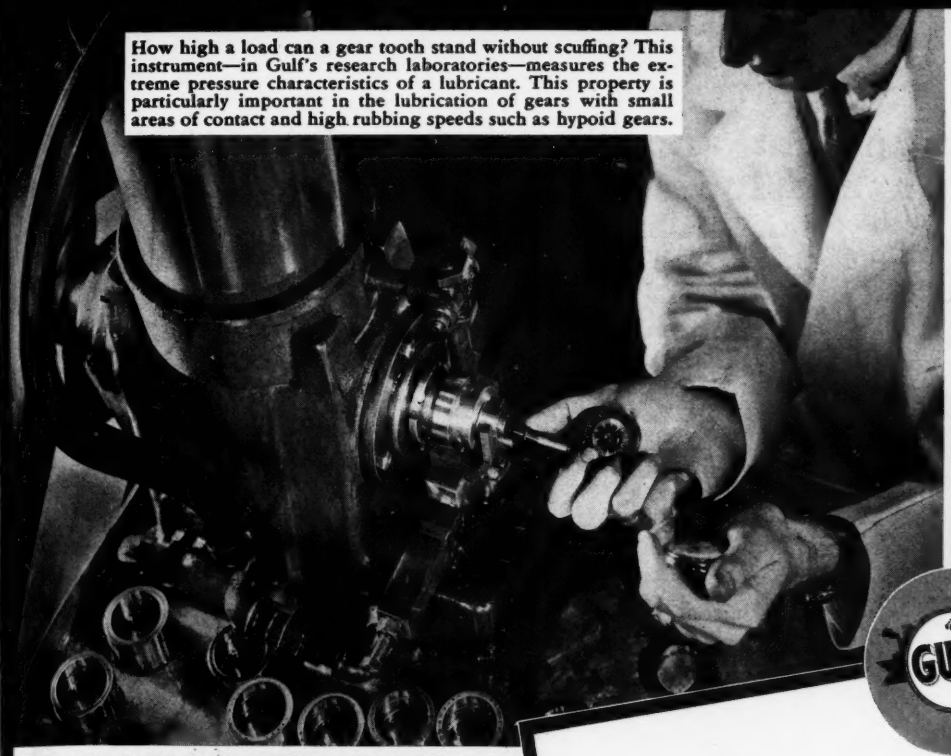
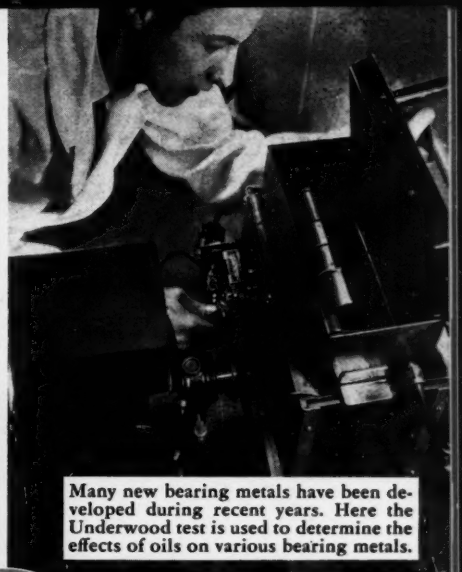
THE AUSTIN METHOD



How high a load can a gear tooth stand without scuffing? This instrument—in Gulf's research laboratories—measures the extreme pressure characteristics of a lubricant. This property is particularly important in the lubrication of gears with small areas of contact and high rubbing speeds such as hypoid gears.



Many new bearing metals have been developed during recent years. Here the Underwood test is used to determine the effects of oils on various bearing metals.

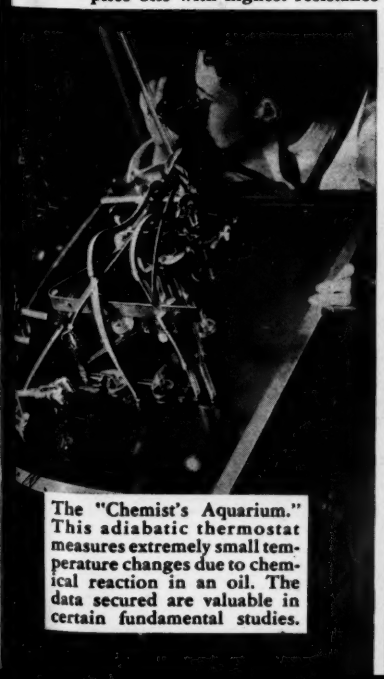
GULF INDUSTRIAL LUBRICATION

Know WHAT'S BEHIND QUALITY CLAIMS WHEN YOU BUY LUBRICANTS ...*Industrial or Automotive*

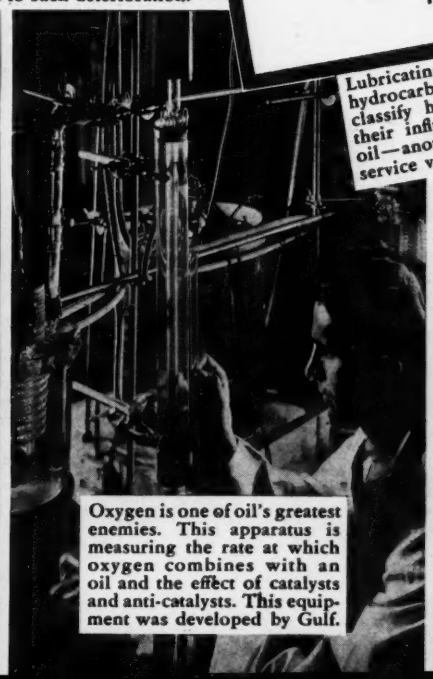
GULF REFINING COMPANY
GULF OIL CORPORATION
GENERAL OFFICES: GULF BUILDING
PITTSBURGH, PA.

This complicated apparatus—in Gulf's laboratories—is used to study the behavior of oils at high temperatures in the presence of oxygen. Some oils deteriorate more rapidly than others under these conditions, forming organic acids, insoluble sludges, and soluble impurities of high viscosity. Samples of the oil are withdrawn at frequent intervals for test, and changes measured. Gulf supplies oils with highest resistance to such deterioration.

Lubricating oils contain many types of hydrocarbon molecules. Gulf scientists classify hydrocarbons with respect to their influence on the stability of the oil—another step to insure the high service value of Gulf quality lubricants.



The "Chemist's Aquarium." This adiabatic thermostat measures extremely small temperature changes due to chemical reaction in an oil. The data secured are valuable in certain fundamental studies.



Oxygen is one of oil's greatest enemies. This apparatus is measuring the rate at which oxygen combines with an oil and the effect of catalysts and anti-catalysts. This equipment was developed by Gulf.

A new machine developed by Gulf engineers—the first that will test any bearing under precisely the operating conditions of actual service. It measures accurately friction, torque, temperature, wear and film thickness. Thus, Gulf research engineers develop new information which is useful in the manufacture of improved bearing lubricants.

Machinery, Equipment and Supplies Used in The Production, Transmission and Utilization of Power

Air Compressors
De Laval Steam Turb. Co.
General Electric Co.
Ingersoll-Rand Co.

Air Filters
Marshalltown Mfg. Co.

Air Preheaters
Babcock & Wilcox Co.
Buffalo Forge Co.
Green Fuel Economizer Co.
Superheater Co., The

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Badger & Sons Co., E. B.
Buffalo Forge Co.

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Carborundum Co., The
Norton Co.

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Timken Roller Bearing Co.

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Robins Conveying Belt Co.
Stephens-Adamson Mfg. Co.

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De Laval Steam Turb. Co.
Ingersoll-Rand Co.
Sturtevant Co., B. F.
Superheater Co., The

Blowers Forced Draft, Portable, Pressure & Coal
Buffalo Forge Co.
Green Fuel Economizer Co.

Blowers, Tube
Bayer Company

Blowers, Turbine
Elliott Co.
Moore Steam Turb. Corp.
Terry Steam Turbine Co.

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Henssey De-Concentrator Co.
National Aluminate Corp.

Boiler Compounds
Betz, W. H. & L. D.

Boiler Feeders
Morehead Mfg. Co.

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Graver Tank & Mfg. Co., Inc.
Permutit Co.

Boiler Setting Cement
Carborundum Co., The
Norton Co.

Boiler Settings
Carborundum Co., The
Norton Co.

Boiler Tubes
Timken Steel & Tube Co.

Boiler Water Treatment
Graver Tank & Mfg. Co., Inc.

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Frick Co.
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Wickes Boiler Co.

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Stephens-Adamson Mfg. Co.

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Austin Co.

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Smooth-On Mfg. Co.

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Eagle-Picher Lead Co.
Johns-Manville, Inc.
Keasbey & Mattison Co.
Norton Co.

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Babbitt Steam Spec. Co.

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Betz, W. H. & L. D.
Graver Tank & Mfg. Co., Inc.
Hagan Corp.
National Aluminate Corp.
Permutit Co.
Scaife & Sons Co., Wm. B.

Cinder Traps
Green Fuel Economizer Co.

Coal, Ash Handling and Storage Equipment
Blaw-Knox Co.
Robins Conveying Belt Co.
Stephens-Adamson Mfg. Co.

Coal Crushers
Stephens-Adamson Mfg. Co.

Coal Weighing & Measuring Equipment
Stephens-Adamson Mfg. Co.

Cocks, Air and Steam
Crane Co.
Dart Mfg. Co., E. M.
Lunkenheimer Co.
Williams Valve Co., D. T.

Combustion Control System
Bailey Meter Co.
Hagan Corp.
Hays Corp., The
Republic Flow Meters Co.

Combustion Engineers
Hagan Corp.

Combustion Recorders
Brown Inst. Co.
Foxboro Co.
Hays Corp., The
Permutit Co.
Pierce Co., Wm. B.
Republic Flow Meters Co.

Compound, Pipe Joint
Smooth-On Mfg. Co.

Compressors, Ammonia
Frick Co.

Condensers
Allis-Chalmers Mfg. Co.
American St. Pump Co.
Anderson Co., The V. D.
Elliott Co.
Frick Co.
Ingersoll-Rand Co.
Superheater Co., The

Construction, Steel Plate
Graver Tank & Mfg. Co., Inc.

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General Elec. Co.

Conveying Systems
Robins Conveying Belt Co.
Stephens-Adamson Mfg. Co.

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Badger & Sons Co., E. B.
Buffalo Forge Co.
Marley Co., The
Sturtevant Co., B. F.
Yarnall-Waring Co.

Cooling Towers
Marley Co., The

Couplings, Flexible
American Blower Corp.
Nicholson & Co., W. H.
Terry Steam Turbine Co.

Couplings, Union
Dart Mfg. Co., E. M.

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Whiting Corp.

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Cochrane Corp.
Elliott Co.

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Henssey De-Concentrator Co.

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Swartwout Co., The

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Austin Co.

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Buffalo Forge Co.
Swartwout Co., The
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Marshalltown Mfg. Co.
Permutit Co.
Scaife & Sons Co., Wm. B.

Feed Water Heaters and Purifiers
Cochrane Corp.
Scaife & Sons Co., Wm. B.
Superheater Co., The
Swartwout Co., The

Feed Water Treatment
Allis-Chalmers Mfg. Co.
Betz, W. H. & L. D.
Graver Tank & Mfg. Co., Inc.
Hagan Corp.
National Aluminate Corp.
Permutit Co.
Scaife & Sons Co., Wm. B.

Filters, Air
Marshalltown Mfg. Co.

Filters, Oil
Anderson Co., The V. D.
Burt Mfg. Co.

Filters, Water
Cochrane Corp.
Graver Tank & Mfg. Co., Inc.
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Babcock & Wilcox Co.
Carborundum Co., The
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Frick Co.

Fittings, Flange and Pipe
Crane Company
Dart Mfg. Co., E. M.
Kennedy Valve Mfg. Co.

Floats
Anderson Co., The V. D.
Hercules Float Works
Reliance Gauge Col. Co.

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Blaw-Knox Co.

Flow Meters
Bailey Meter Co.
Brown Inst. Co.
Cochrane Corp.
Republic Flow Meters Co.

Flue Cleaners
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Springfield Boiler Co.

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Babcock & Wilcox Co.
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Hays Corp., The

Gaskets
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Ernst Water Col. & Gage
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Gauges, Draft, Liquid Level
Bailey Meter Co.
Brown Instrument Co.
Foxboro Co.
Hays Corp., The
Pierce Co., Wm. B.
Republic Flow Meters Co.

Gauges, Indicating Pressure
Marshalltown Mfg. Co.

Gauges, Recording Pressure
Crosby Steam Gage & Valve Co.
Foxboro Co.
Hays Corp., The

Gauges, Water
Ernst Water Col. & Gage
Lunkenheimer Co.
Reliance Gauge Col. Co.
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De Laval Steam Turb. Co.
Moore Steam Turb. Corp.
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Generating Sets
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Moore Steam Turb. Corp.
Murray Iron Wks. Co.
Sturtevant Co., B. F.
Terry Steam Turbine Co.
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Allis-Chalmers Mfg. Co.
Elliott Co.
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Moore Steam Turb. Corp.
Murray Iron Wks. Co.
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Standard Oil Co.
Texas Co., The
Tide Water Oil Co.

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Lubricators
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Mechanical Draft Apparatus
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Buffalo Forge Co.
Green Fuel Economizer Co.
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Meters, Air and Gas
Bailey Meter Co.
Republic Flow Meters Co.

Meters, Boiler
Bailey Meter Co.
Brown Inst. Co.
Hays Corp., The
Republic Flow Meters Co.

Meters, Coal
Bailey Meter Co.
Republic Flow Meters Co.

Meters, Water and Steam
American Dist. Steam Co.
Bailey Meter Co.
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Hensxey De-Concentrator Co.
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Meters, V-Notch
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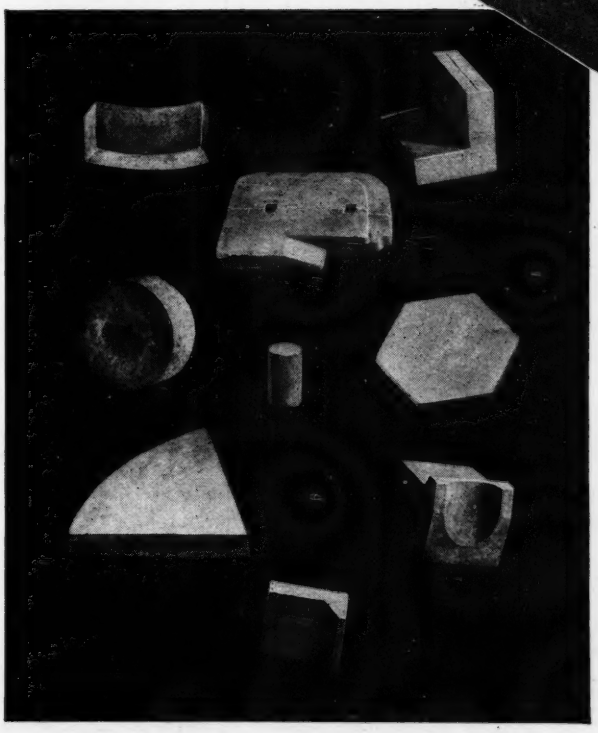
Monel Metal Rings, Rods, Castings, Forgings, Tubings, Sheets, Wire and Wire Cloth
International Nickel Co.

Cost of Special Shapes Running High?

Unusual shapes like this large burner block and the smaller shapes shown are easily and inexpensively cast with J-M Firecrete.

Save time and money by casting shapes yourself with J-M Firecrete . . . the hydraulic-setting refractory cement that handles as easily as concrete!

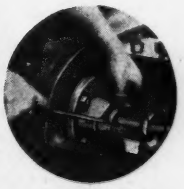


Mix Firecrete with water . . . like concrete . . . and cast your own refractory shapes right on the job!

That's the way to end the high costs and long delays involved in buying special shapes. Also it eliminates the need of carrying stocks of expensive shapes that may only be used at irregular intervals. Exceptionally strong and resistant to spalling, Firecrete has practically no drying or firing shrinkage. It is ideally suited for poured linings for doors, pipes or flues, and for dampers. Can be placed in service after only 12 hours' curing.

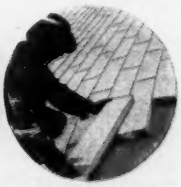
Available in three types: Standard for temperatures up to 2400°F.; High Temperature for use up to 2800°F.; Light Weight (40% lighter in weight and heat-storage capacity than firebrick, with less than half its conductivity) for temperatures up to 2400°F. For Engineering Data Sheets on Firecrete, and other J-M Cements for setting firebrick, patching and wash-coating, write Johns-Manville, 22 E. 40th St., N.Y.C.

Johns-Manville POWER PRODUCTS



PACKINGS

REFRACTORIES



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General Electric Co.

Nozzles for All Purposes
Marley Co., The
Monarch Mfg. Wks., Inc.
Yarnall-Waring Co.

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Lunkenheimer Co.
Williams Valve Co., D. T.

Oiling Systems
Burt Mfg. Co.

Oil Purifiers
De Laval Steam Turb. Co.

Oil Removing Filters
Scaife & Sons Co., Wm. B.

Oil Tanks
Graver Tank & Mfg. Co., Inc.
Mansel Bros. Co.

Oils, Lubricating
Gulf Refining Co.
Socony-Vacuum Oil Co.
Standard Oil Co.
Texas Co., The
Tide Water Oil Co.

Packing, Asbestos, Flax and Metallic
Chesterton Co., A. W.
Crane Packing Co.
Garlock Pkg. Co.
Johns-Manville, Inc.
Keasbey & Mattison Co.

Packing, Metallic, For Condenser Tubes
Crane Packing Co.
Garlock Pkg. Co.
Johns-Manville, Inc.

Packing, Piston and Rod, Valve Stem
Chesterton Co., A. W.
Crane Packing Co.
Garlock Pkg. Co.
United States Rubber Co.

Packing, Sheet Valve, Pump
Carey Co., The Philip
Chesterton Co., A. W.
Garlock Pkg. Co.
Jenkins Bros.
Johns-Manville, Inc.
United States Rubber Co.

Pipe Coils and Bends
Badger & Sons Co., E. B.
Frick Co.
Superheater Co., The
Vogt Machine Co., Henry

Pipe Covering
American Dist. Steam Co
Johns-Manville, Inc.
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Connery Const. Co.
Timken Steel & Tube Co.

Pipe Savers
Sarco Co., Inc.

Pianimeters
Foxboro Co.

Power Houses, Design and Construction
Austin Co.

Power Transmission Machinery
Stephens-Adamson Mfg. Co.
Whiting Corp.

Pumping Systems, Air Lift
Ingersoll-Rand Co.

Pumps, Boiler Feed
Allis-Chalmers Mfg. Co.
American St. Pump Co.
De Laval Steam Turb. Co
Ingersoll-Rand Co.
Moore Steam Turb. Corp.
Warren Steam Pump Co.

Pumps, Centrifugal
Allis-Chalmers Mfg. Co.
American St. Pump Co.
De Laval Steam Turb. Co
Ingersoll-Rand Co.
Moore Steam Turb. Corp.
Warren Steam Pump Co.

Pumps, Elevator, Fire and General Service
American St. Pump Co.
De Laval Steam Turb. Co
Warren Steam Pump Co.

Pumps, Hydraulic Pressure
American St. Pump Co
Warren Steam Pump Co.

Pumps, Oil
American St. Pump Co.
Mansel Bros. Co.

Pumps, Power & Electric
American St. Pump Co
Warren Steam Pump Co.

Pumps, Turbine
Moore Steam Turb. Corp.
Warren Steam Pump Co.

Pumps, Vacuum
American St. Pump Co.
Ingersoll-Rand Co.
Warren Steam Pump Co.

Pumps, Waterworks
American St. Pump Co.
Moore Steam Turb. Corp
Warren Steam Pump Co.

Purifiers, Boiler Feed
Graver Tank & Mfg. Co., Inc.
Permutit Co.
Scaife & Sons Co., Wm. B
Sarco Co., Inc.

Purifiers, Steam
Blaw-Knox Co.
Hagan Corp.
Marley Co., The
Morehead Mfg. Co.

Pyrometers
Brown Inst. Co.
Republic Flow Meters Co.
Superheater Co., The

Recording Instruments
Foxboro Co.
Hays Corp., The

Refractories
Babcock & Wilcox Co.
Carborundum Co., The
Johns-Manville, Inc.
Keasbey & Mattison Co.
Norton Co.

Regulators, Damper
Brown Inst. Co.
Hagan Corp.
Hays Corp., The

Regulators, Feed Water
Bailey Meter Co.
Chaplin-Fulton Mfg. Co
Northern Equipment Co.
Sarco Co., Inc.
Squires Co., C. E.
Swartwout Co., The

Regulators, Pressure
Chaplin-Fulton Mfg. Co.
Hagan Corp.
Hays Corp., The
Northern Equipment Co.
Sarco Co., Inc.
Squires Co., C. E.
Strong, Carlisle & Hammond Co.

Regulators, Temperature
Brown Inst. Co.
Foxboro Co.
Sarco Co., Inc.

Scale Removers, Mechanical
Elliott Co.
Pierce Co., Wm. B.

Scale Removing Compounds
Betz, W. H. & L. D.

Seamless Tubes
Timken Steel & Tube Co.

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Commercial Testing & Eng'r'g Co.

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Anderson Co., The V. D.
Blaw-Knox Co.
Cochrane Corp.
Direct Separator Co.
Hagan Corp.
Marley Co., The
Strong, Carlisle & Hammond Co.
Williams Valve Co., D. T
Swartwout Co., The

Shafting
Timken Steel & Tube Co.

Sodium Aluminate
National Aluminate Corp

Soot Blowers
Bayer Company

Speed Indicators
Biddle Co., Jas. G.

Speed Reducers
Stephens-Adamson Mfg. Co.

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Badger & Sons Co., E. B.
Marley Co., The
Monarch Mfg. Wks.

Sprocket Rims
Babbitt Steam Spec. Co.

Stacks, Metal
Connery Const. Co.
Vogt Machine Co., Henry

Stair Tread, Non-Slipping
Blaw-Knox Co.

Steam Traps
American Dist. Steam Co
Anderson Co., The V. D.
Armstrong Mach. Wks.
Cochrane Corp.
Crane Company
Golden-Anderson Valve Spec. Co.
Morehead Mfg. Co.
Sarco Co., Inc.
Squires Co., C. E.
Nicholson & Co., W. H.
Swartwout Co., The
Williams Valve Co., D. T
Yarnall-Waring Co.

Stokers, Mechanical, Overfeed and Grate
American Engrg. Co.
Babcock & Wilcox Co.
Detroit Stoker Co.
Flynn & Emrich Co.
Hoffman Combustion Engrg. Co.
Whiting Corp.

Stokers, Underfeed
American Engrg. Co.
Hoffman Combustion Engrg. Co.
Detroit Stoker Co.
Whiting Corp.

Strainers
Monarch Mfg. Wks., Inc.
Sarco Co., Inc.
Strong, Carlisle & Hammond Co.

Superheaters, Steam
Babcock & Wilcox Co.
Marley Co., The
Superheater Co., The

Switchboards
General Elec. Co.

Tachometers
Biddle Co., Jas. G.
Brown Inst. Co.
Foxboro Co.

Tanks
Bros Boiler & Mfg. Co., Wm.
Connery Const. Co.
Graver Tank & Mfg. Co., Inc.
Scaife & Sons Co., Wm. B
Vogt Machine Co., Henry

Thermometers, Dial
Sarco Co., Inc.

Thermometers, Recording & Indicating
Brown Inst. Co.
Foxboro Co.

Traps, Comp. Air, Vacuum
American Blower Corp.
Armstrong Machine Wks.
Nicholson & Co., W. H.
Strong Carlisle & Hammond Co.

Traps, Steam, Radiator and Return
American Blower Corp.
Anderson Co., The V. D.
Armstrong Machine Wks.
Morehead Mfg. Co.
Nicholson & Co., W. H.
Sarco Co., Inc.
Strong, Carlisle & Hammond Co.
Yarnall-Waring Co.

Tube Cleaners, Boiler and Condenser
Elliott Co.
Pierce Co., Wm. B.

Tubing
Timken Steel & Tube Co.

Turbines, Hydraulic
De Laval Steam Turb. Co

Turbines, Steam
Allis-Chalmers Mfg. Co.
De Laval Steam Turb. Co
Elliott Co.
General Electric Co.
Moore Steam Turb. Corp.
Murray Iron Wks. Co.
Terry Steam Turbine Co.
Sturtevant Co., B. F.

Underground Heating Systems
American Dist. Steam Co
Johns-Manville, Inc.

Unions
Crane Company
Dart Mfg. Co., E. M.
Edward Valve & Mfg. Co.

Valve Discs
Garlock Pkg. Co.
Jenkins Bros.
United States Rubber Co.

Valves, Altitude
Golden-Anderson Valve Spec. Co.

Valves, Auto, Cut-off
Edward Valve & Mfg. Co.
Golden-Anderson Valve Spec. Co.
Northern Equipment Co.

Valves, Blow-off
Chapman Valve Mfg. Co.
Crane Company
Crosby Steam Gage & Valve Co.
Edward Valve & Mfg. Co.
Fairbanks Co., The
Lunkenheimer Co.
Yarnall-Waring Co.

Valves, Check
Chapman Valve Mfg. Co.
Crane Co.
Crosby Steam Gage & Valve Co.
Edward Valve & Mfg. Co.
Fairbanks Co., The
Golden-Anderson Valve Spec. Co.
Jenkins Bros.
Kennedy Valve Mfg. Co.
Williams Valve Co., D. T.

Valves, Elec. Operated
Fairbanks Co., The
Frick Co.
Northern Equipment Co.

Valves, Float
Crosby Steam Gage & Valve Co.
Nicholson & Co., W. H.

Valves, Gate and Globe
Chapman Valve Mfg. Co.
Crane Company
Crosby Steam Gage & Valve Co.
Edward Valve & Mfg. Co
Jenkins Bros.
Kennedy Valve Mfg. Co.
Lunkenheimer Co.
Strong, Carlisle & Hammond Co.
Vogt Machine Co., Henry
Williams Valve Co., D. T.

Valves, Hydraulic
Chapman Valve Mfg. Co.
Fairbanks Co., The
Kennedy Valve Mfg. Co.
Nicholson & Co., W. H.
Vogt Machine Co., Henry

Valves, Non-Return
Golden-Anderson Valve Spec. Co.

Valves, Pop Safety
Crane Company
Crosby Steam Gage & Valve Co.
Lunkenheimer Co.

Valves, Plug
Fairbanks Co., The
Nicholson & Co., W. H.

Valves, Pump
Chapman Valve Mfg. Co.
Crosby Steam Gage & Valve Co.
Garlock Pkg. Co.
Jenkins Bros.
United States Rubber Co.

Valves, Radiator
American Dist. Steam Co.
Crane Company
Fairbanks Co., The
Jenkins Bros.
Kennedy Valve Mfg. Co.
Williams Valve Co., D. T.

Valves, Reducing, Regulating and Relief
Chaplin-Fulton Mfg. Co.
Cochrane Corp.
Crosby Steam Gage & Valve Co.
Edward Valve & Mfg. Co.
Golden-Anderson Valve Spec. Co.
Hagan Corp.
Monarch Mfg. Wks., Inc.
Squires Co., C. E.
Strong, Carlisle & Hammond Co.
Swartwout Co., The

Valves, Steel
Chapman Valve Mfg. Co.
Crane Company
Edward Valve & Mfg. Co.
Kennedy Valve Mfg. Co.

Ventilating Apparatus
American Blower Corp.
Badger & Sons Co., E. B.
Buffalo Forge Co.
Burt Mfg. Co.
Sturtevant Co., B. F.
Swartwout Co., The

Waste Heat Recovery Systems
Babcock & Wilcox Co.

Water Columns and Alarms
Ernst Water Col. & Gage
Lunkenheimer Co.
Reliance Gauge Col. Co.
Yarnall-Waring Co.

Water Cooling Equipment
Yarnall-Waring Co.
Marley Co., The

Water Purifying and Softening Systems
Betz, W. H. & L. D.
Cochrane Corp.
Graver Tank & Mfg. Co., Inc.
Hagan Corp.
National Aluminate Corp.
Permutit Co.
Scaife & Sons Co., Wm. B

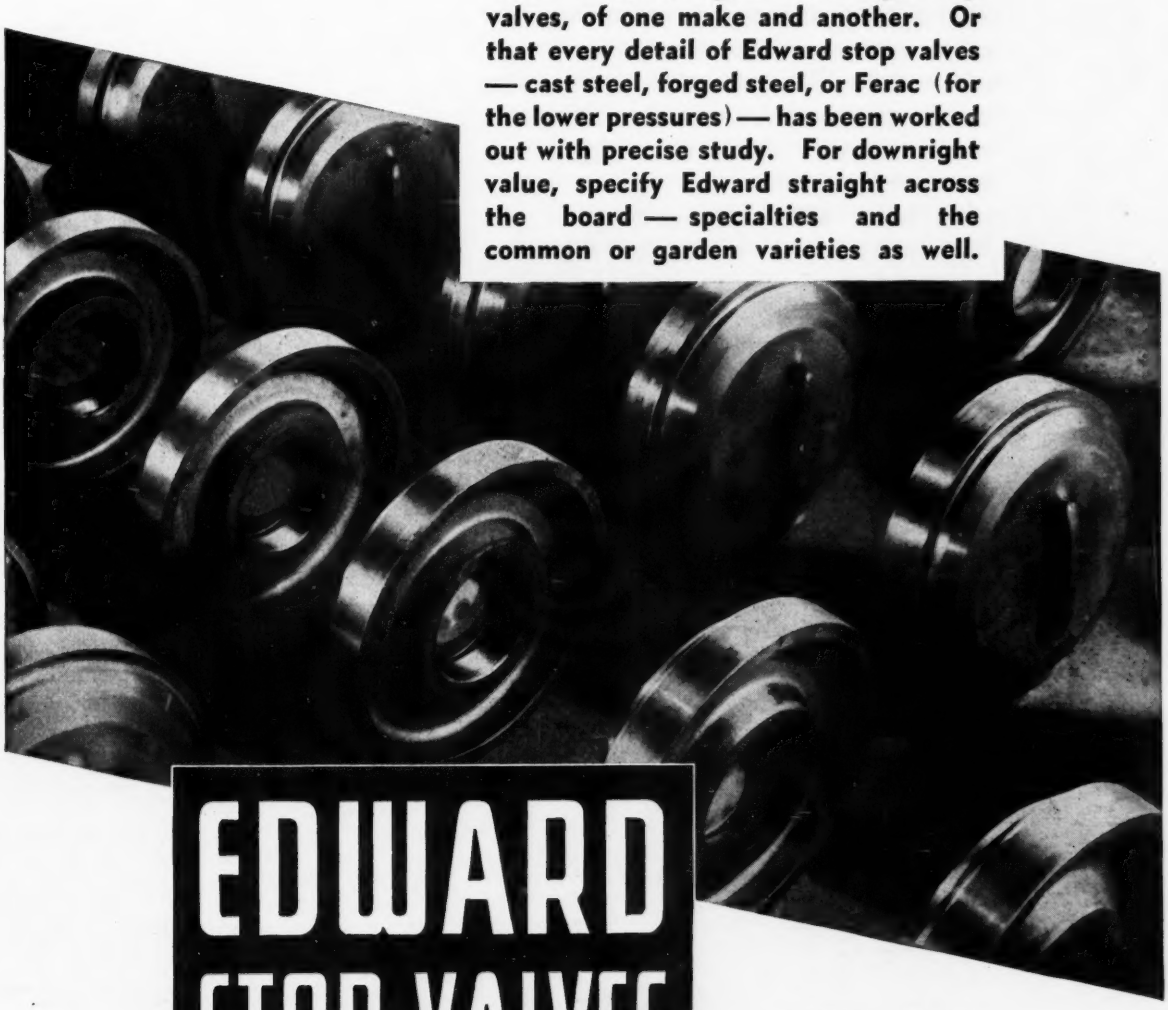
Water Testing Equipment
National Aluminate Corp

Water Walls
Superheater Co., The

Weigh Larries
Stephens-Adamson Mfg. Co.

Whistles
Crosby Steam Gage & Valve Co.
Lunkenheimer Co.

NON-RETURN valves, blow-offs, and feed line stop-check valves — these are admittedly down the specialist's alley. And Edward's leadership in these lines is in the record. But not every buyer realizes how much difference there is between globe and angle stop valves, of one make and another. Or that every detail of Edward stop valves — cast steel, forged steel, or Ferac (for the lower pressures) — has been worked out with precise study. For downright value, specify Edward straight across the board — specialties and the common or garden varieties as well.



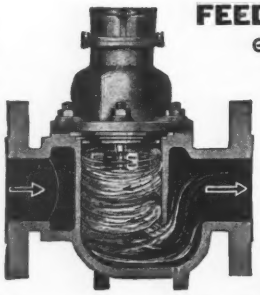
EDWARD pedigreed forged EValloy disks like these give plus value to EDWARD stop valves.

EDWARD STOP VALVES *Excel, too*

The Edward Valve & Manufacturing Co., Inc.

EAST CHICAGO INDIANA

— HENSZEY —



FEED WATER METERS

GO RIGHT IN THE FEED LINE—

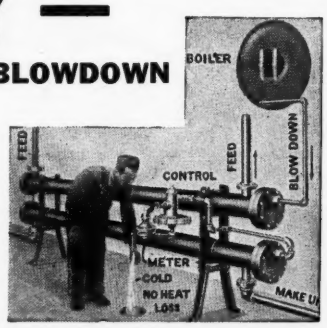
They register within 2% of absolute accuracy, regardless of the dirt or heat content of the water.

They accurately measure the pulsating discharge of reciprocating pump.

CONTINUOUS BLOWDOWN

REMOVES THE CAUSE OF THE TROUBLE.

No Scale
No Foaming
No Priming



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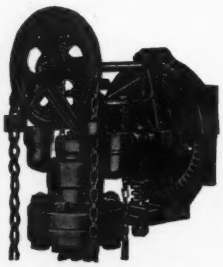
HENSZEY DE-CONCENTRATOR CO., WATERTOWN, WIS.

CHRONILLOY ELEMENTS

HOW MUCH IS IT COSTING you to maintain the SOOT CLEANER ELEMENTS in the HIGH TEMPERATURE positions of your boilers? Here is an element sold with an 18 MONTHS SPECIAL UNQUALIFIED SERVICE GUARANTEE. COST MORE? Yes, but WHAT SERVICE LIFE!



BALANCED VALVE-IN-HEAD

FIRST QUALITY IN DESIGN, WORKMANSHIP AND MATERIAL. Back of this IMPROVED SOOT CLEANER HEAD lies years of study to make it trouble free and give dependable service day after day. Analyze before you buy as cheap imitations may be offered . . . . . .

THE BAYER COMPANY

4065 Park Ave. St. Louis, U. S. A.

SIGNBOARD SECTION

EQUIPMENT FOR SALE

Uniflow and 4 Valve Units

KVA	MAKE	LOCATION
750	G.E.—Ames Uniflow	N. Y.
750	G.E.—Erie City, poppet valve	Minn.
375	C.W.—Ames vertical Uniflow	Conn.
312	Al.Chal.—Al. Chal. Corliss	Wis.
312	Al.Chal.—Erie Ball 4 V.	Mich.
250	G.E. Turbine Unit (new)	N. Y.
250	G.E.—Chuse 4 V.	Mont.
150	Wghse.—Erie Ball 4 V.	Texas
100	G.E.—Skinner Uniflow	Neb.

BOILERS:

823 HP three Stirling, 200 lbs. ASME....Mich.
400 HP four Connelly, 200 lbs. ASME..Ohio

DIRECT CURRENT UNITS, 250 VOLTS

KW	MAKE	LOCATION
1000	Al.Chal.—Al. Chal. Corliss	Ohio
300	G.E. Turbine	Ill.
300	G.E.—Skinner UNIFLOW	N. Y.
300	Wghse. Turbine	Pa.
250	C.W.—Skinner UNIFLOW	N. Y.
250	G.E.—Erie Ball 4 V.	Pa.
200(2)	Ridgeway—Ridgeway 4 V.	Pa.
200	G.E.—Harrisburg	Pa.
200	G.E.—Erie Ball 4 V.	N. Y.
200	G.E.—DeLaval Turbine	N. C.
150	Wghse.—Erie Ball 4 V.	Pa.
150	Rdgw.—Rdgw. 4 V.	Pa.
100	G.E.—Erie Ball	Pa.
100	Wghse. Turbine	N. Y.
50	G.E.—G. E. ver. Engine	Pa.

ENGINE: (Belted) 17x18 Skinner Uniflow. Diesel Oil Engine Units; Compressors; Pumps, Motors, etc.

Power Plant Equipment Co., Inc.
39 Cortlandt St., New York

EQUIPMENT FOR SALE

50 Kw. D.C. Turbo, 125-250V. with Switchboard.
75 Kw. 250V. D.C. Turbo, with Switchboard.
100 Kw. Generator. 250V. dir. con. 15x16—Uniflow Skinner Engine.
20T. Hand Crane, 50'10" span. fish belly type.
1500 Kw. 60 Cy. 3 Ph. non-cond. Turbo.
1000 Kw. bleeder type Turbo, 60 Cy. 3 Ph.

ROSS POWER EQUIP. CO.
Indianapolis, Ind.

LAST WORD IN SUPER-POWERED CLEANERS

The Ideal "Jumbo" gives you 3 in 1 performance not duplicated by any other electric cleaner. Blows — vacuums — sprays. FREE TRIAL.

IDEAL COMMUTATOR DRESSER COMPANY
1033 Park Avenue
Sycamore, Illinois

HELP WANTED

Mechanical Engineer—Graduate as assistant engineer, experienced engineering design steam power stations specifications piping etc. State age, education, experience, full particulars, salary expected. Replies held strictly confidential. Address "Mechanical Engineer, Box 163 Trinity Station, New York, N. Y."

"Wanted—Mechanical Draftsman with experience in high pressure Central Station piping and equipment layout work. State education, experience, salary desired, and when available. Location—Southeast." Address Box 1263, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

SALESMEN WANTED

SALES ENGINEERS & JOBBERS ATTENTION! Men who are looking to the future as well as the present—A young, rapidly expanding business, manufacturing and servicing colloidal water treatments, needs such salesmen in Chicago and other territories. The best producer will be selected as sales manager. Give complete details on experience, age, etc. Our men have been informed of this ad. All replies will be held confidential. Address Box 1262, c/o Power Plant Engineering.

Additional salesmen wanted for internationally prominent line of engine room, operating and building maintenance products used and endorsed by foremost concerns in respective industries. Saleable to all types of industrial plants and institutions. Constant repeat business. Percentage or weekly drawing if satisfactory. Permanent, dignified, lucrative connection. To receive consideration, give five character references and detail last five years' business activities. Address Box 1264, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

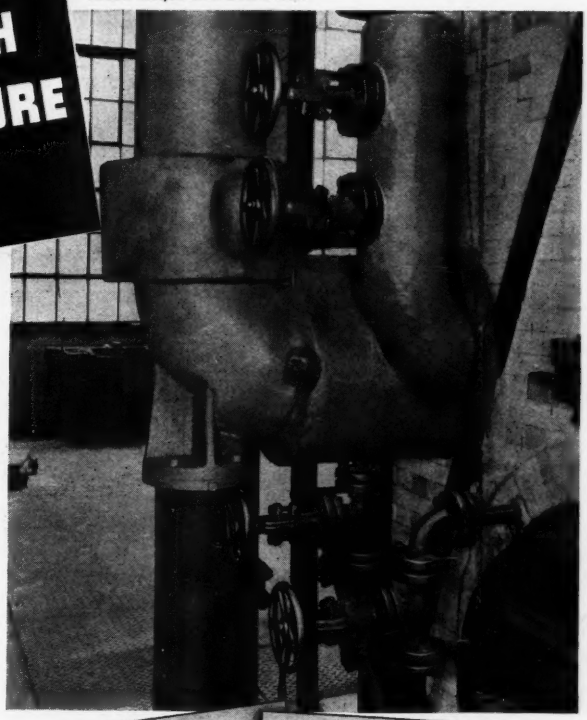
POSITIONS WANTED

GRADUATE ELECTRICAL ENGINEER. Texas A. & M. College Degree. Varied mechanical and electrical experience with power plants and railroads both in the shop and drafting room. Well versed in advanced mathematics. Prefers employment with electric railroad or power plant but will be glad to accept work with steam railroad or any kind of electrical work. Any job to start. Available immediately and will go anywhere. Please write to Box 1260, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

Engineer wishes position. 11 yr. practical experience in general utility work including 8 yr. in power plants. Milwaukee, Wis., and Minnesota license, 31 yr. old, married. Will go anywhere in Wis., Minn. & N. & S. Dakota. Please reply to Box 1246, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

Triplex Steel BOLT-STUDS FOR HIGH PRESSURE-TEMPERATURE CONDITIONS

For dimensions, list prices, thread and nut data on Crane Triplex Steel Bolt-Studs see page 355, new Crane No. 52 Catalog. Complete technical data on Crane bolting is given on pages 724 and 725, including tables showing the relation between torque and bolt stress.



● The use of higher and higher steam pressures and temperatures demands much of bolt-stud metals. Crane Co.'s metallurgical department anticipated the requirements of higher pressures and temperatures and produced the metals to cope with them. Continuous research has provided the right materials for each successive boost in pressures.

Crane Triplex Steel Bolt-Studs of chrome-nickel steel, for instance, have ample reserve strength to meet the most severe temperature-pressure combinations now in use. Should still further increases be made in pressures and temperatures, Crane Co. is ready to meet the conditions.

The Crane line of valves, fittings and fabricated piping is complete. A branch or distributor is nearby, ready to serve you.

Be sure to see our exhibit at the Twelfth National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York, November 30 to December 5.

CRANE

CRANE CO., GENERAL OFFICES: 836 S. MICHIGAN AVE., CHICAGO, ILLINOIS • NEW YORK: 23 W. 44TH STREET

Branches and Sales Offices in One Hundred and Sixty Cities

VALVES, FITTINGS, FABRICATED PIPE, PUMPS, HEATING AND PLUMBING MATERIAL

Paths to Greater Usefulness

In engineering research, there is no end to any road. Every discovery, every bit of knowledge—even every failure—may suggest entirely new fields for study.

One research trail led to the development of the electron tube and such applications as radiobroadcasting, smoke detection, feedwater control, current conversion, motor control, and a host of services.

Other research trails have produced mercury vapor boilers, roller bearings, high capacity and high voltage circuit breakers, the impulse generator used in lightning investigations.

Dr. Willis R. Whitney, Vice President in Charge of Research for the General Electric Company, sees in the future the promise of yet greater achievements. "Discoveries and inventions are not terminals," he recently said, "they are fresh starting points from which we can climb to new knowledge."

Fresh starting points, new trails, paths to greater usefulness —these are the goals of alert manufacturers of power plant equipment and supplies. You will find their advertisements in POWER PLANT ENGINEERING convenient and reliable bulletins on new products—what they are, how they work and how they can save. The advertisements of these manufacturers shorten the gap between invention and utilization.

The Bystander

NEW YORK STEAM CORPORATION *Uses*

American Blower Mechanical Draft Fans

No other city in the world presents a more difficult heating problem than that of New York City. Yet, so effectively has New York's heating been handled by modern, efficient New York Steam Corporation and others, that the layman is not even conscious of how this city of super-skyscrapers is heated.

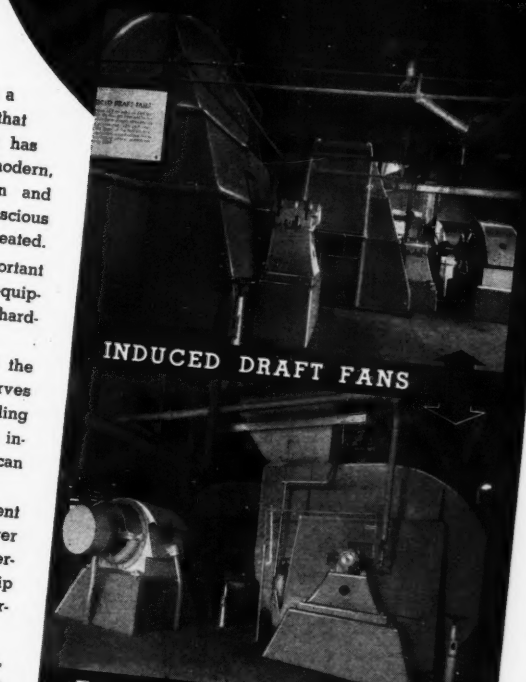
In this complex system, as in other important areas, American Blower mechanical draft equipment will be found on 24-hour duty in the hardest possible service for fan equipment.

For example: At the Kips Bay Station of the New York Steam Corporation, which serves many of the city's bigger buildings, including the Empire State Building, all boiler units installed since 1928 are equipped with American Blower Forced and Induced Draft Fans. Here, on the largest boiler unit (the equivalent of 12 stories in height), two American Blower high efficiency "MD" Radial Blade Fans operating in parallel at 21,000 feet per minute tip speed are used for induced draft and two American HS Fans provide forced draft.

From this giant pulverized fuel-fired boiler unit, designed for 750,000 lbs. of steam per hour, as high as 1,100,000 lbs. has been produced in a single hour—an achievement only possible with the finest of fan equipment.

Such performance is typical of American Blower Products, and merits your serious consideration in the selection of mechanical draft equipment for your power plant. Phone or write for complete data.

AMERICAN BLOWER CORPORATION
6000 RUSSELL ST. • DETROIT, MICHIGAN
BRANCH OFFICES IN ALL PRINCIPAL CITIES



Who Uses Them?

The New York Steam Corporation uses American Blower Mechanical Draft Equipment at the Kips Bay Station and here's a partial list of other users:

Wilson & Company
Chicago, Ill.
Kansas City Power & Light Co.
Northeast Station
Grand Avenue Station
Kansas City, Mo.
Dow Chemical Company
Midland, Michigan
Philadelphia Electric Company
Richmond Street Station
Philadelphia, Pa.
Jones & Laughlin Steel Corp.
Eliza Works
Aliquippa Works
Pittsburgh, Pa.
Tennessee Eastman Corp.
Kingsport, Tenn.
Potomac Electric Power Co.
Buzzard's Point Station
Washington, D. C.
Long Island Lighting Co.
Glen Head Station
Northport Station
Far Rockaway Station
Long Island, N. Y.
So. Indiana Gas and Electric Co.
Ohio River Station
Evansville, Ind.
Hershey Chocolate Company
Hershey, Pa.
Chevrolet Motor Company
Detroit, Michigan
Consumers Power Company
Saginaw River Steam Plant
Zilwaukee, Mich.
Wealthy Street Steam Plant
Grand Rapids, Mich.
Container Corp. of America
Manayunk, Philadelphia, Pa.

AMERICAN BLOWER CORPORATION

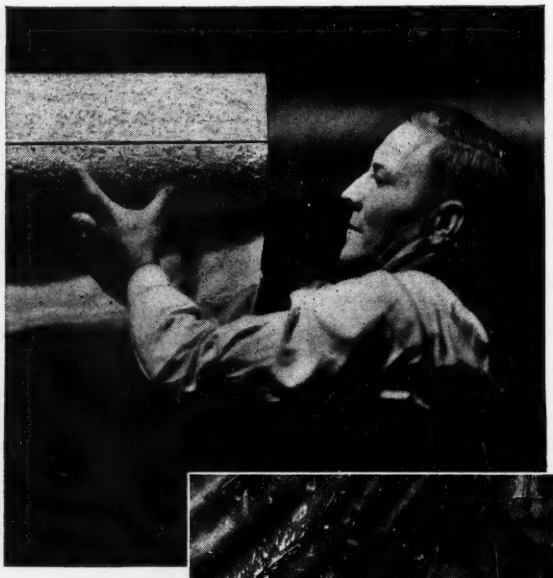
Division of American Radiator & Standard Sanitary Corporation

UP ... goes Power-Plant Efficiency AND

J-M INSULATIONS WIPE OUT HEAT LOSSES ... CUT FUEL COSTS

No need to sell insulations, as such, to a power plant. Wherever heat is generated for energy, the importance of insulation is obvious. And its part in wiping out major heat losses ... in slashing fuel costs ... is tremendous. Providing, of course, these insulations are right in amount, kind and application. Therefore, consider this:

Johns-Manville makes and recommends a particular insulation especially suited to every specific power-plant requirement. And every J-M Insulation, by its permanently high efficiency, reflects the research and manufacturing skill that go into its making! Whether it be for piping—boiler settings and drums, economizers, breechings, turbines, pumps or feed-water heaters—a J-M Insulation is available for assuring the manifold advantages of maximum insulating value.



REFRACTORY MAINTENANCE MINIMIZED BY USE OF J-M REFRACTORY CEMENTS

You take another step in reducing operating and maintenance costs when you use J-M Refractory Cements. Backed by a successful 20-year service record, today's line of J-M Refractory Cements is sufficiently wide in range to meet every need. Their use in bonding firebrick and in washcoating refractory walls provides protection against slagging and spalling ... assures long refractory life with minimum maintenance.

DOWN ... goes the cost of Operation!

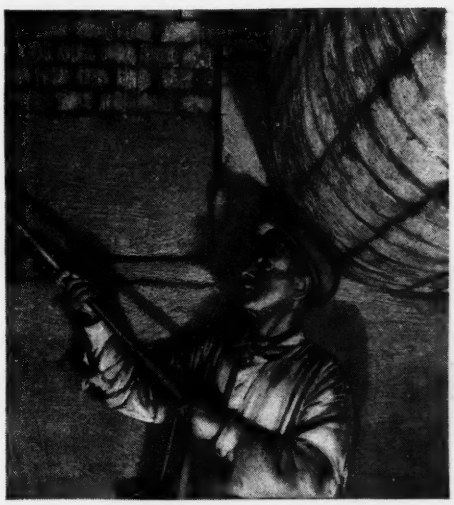
Improved performance ... reduced operating and maintenance charges ... are effected by the combined use of J-M INSULATIONS ... PACKINGS ... and REFRACTORIES

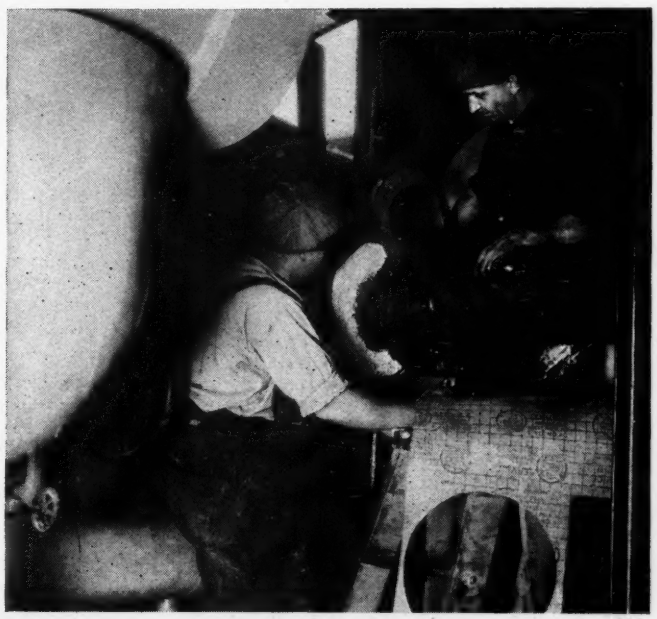
DESIGNED for widely varied service conditions, J-M Insulations, Packings and Refractories have in common important advantages . . . highly pertinent to efficient, economical power-plant operation.

They are, all three, products of Johns-Manville research and rigid manufacturing control. Today, they represent the sum total of years of constant development and improvement. Today—through their quality, performance and range—they offer engineers the solution to many a power-plant problem demanding increased efficiency and reduced operating costs as its answer.

Why not get the full story . . . not only on J-M Insulations, Packings and Refractories . . . but also on the many other J-M products that can help you keep costs down in your plant? Our new Industrial Products Catalog is now ready. For your copy, write Johns-Manville, 22 East 40th Street, New York City.

[Be sure to watch for Johns-Manville at the Power Show]





REDUCE WEAR ON POWER-PLANT EQUIPMENT BY USE OF J-M PACKINGS

For rods, plungers, valve stems, pistons . . . or any other power-plant service . . . the right J-M Packing is designed to give greater dependability and economy. Because J-M Packings are so lastingly dependable . . . and do reduce wear on equipment . . . they cut down on the replacements and shutdowns that can send maintenance expense sky-high.

Johns-Manville POWER PRODUCTS

INSULATIONS PACKINGS REFRACTORIES

Important News to Valve Users

Fig. 057
Non-rising stem valve with screwed ends

Fig. 058
Non-rising stem valve with flanged ends

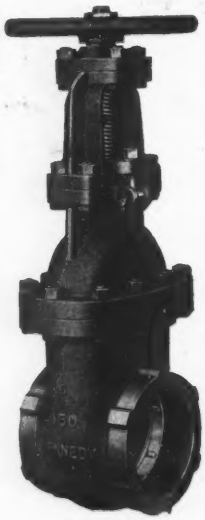


Fig. 0601
Rising stem and yoke valve with screwed ends

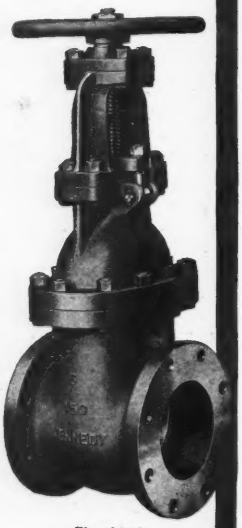
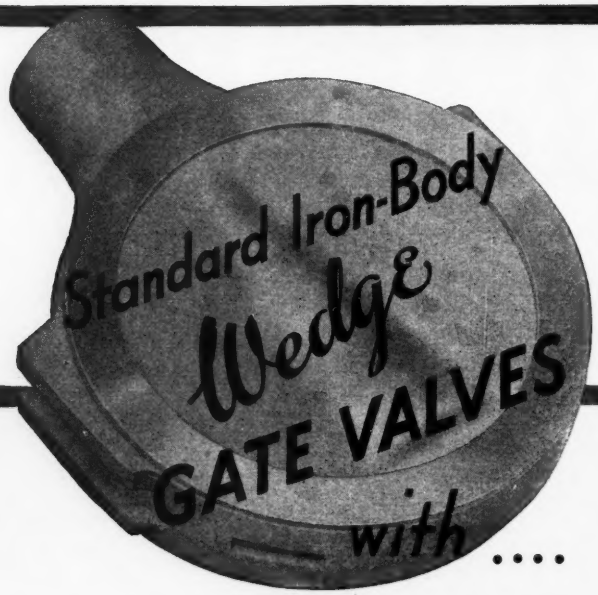


Fig. 0611
Rising stem and yoke valve with flanged ends



. . . literally a host of special features that make these valves easy to operate, resistant to destructive influences, thoroughly dependable, and economical to maintain. Every part from handwheel to pipe ends is designed to meet the most exacting requirements, and many of the refinements of these new valves are unobtainable in any other design.

If You Want To Know

how the stems are protected from scoring

why the stuffing box bolts cannot get in the way or their nuts and washers become lost while repacking

why handwheel rims have 20 to 100 per cent greater effective grasping surface than those of other designs

how stems are prevented from side motion when starting to open the valves

how annoyance of broken studs and difficulties of handling bolts and nuts are eliminated

how time is saved in connecting up to pipe lines

what is the unique packing arrangement that retains its tightness with either steam or water

why the stuffing box bolts and nuts cannot stick together

. . . and the remainder of the 33 special features that make these valves the best value on the market—

Send The Coupon For Bulletin In Which These Features Are Fully Described

The Kennedy Valve Mfg. Co., Elmira, N. Y.

Send Coupon for Bulletin

The Kennedy Valve Mfg. Co., Elmira, N. Y.
Please send bulletin on your new Standard Iron-body Wedge Gate Valves.
Name .....
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PPE

KENNEDY
Standard Iron-Body *Wedge* Gate Valves

COCHRANE

Deaerating Type
HOT PROCESS SOFTENER

This system—a complete water conditioner developed by Cochrane and applied to a great number of modern high-pressure boiler plants—combines in one apparatus the three functions of softening, heating and deaeration.

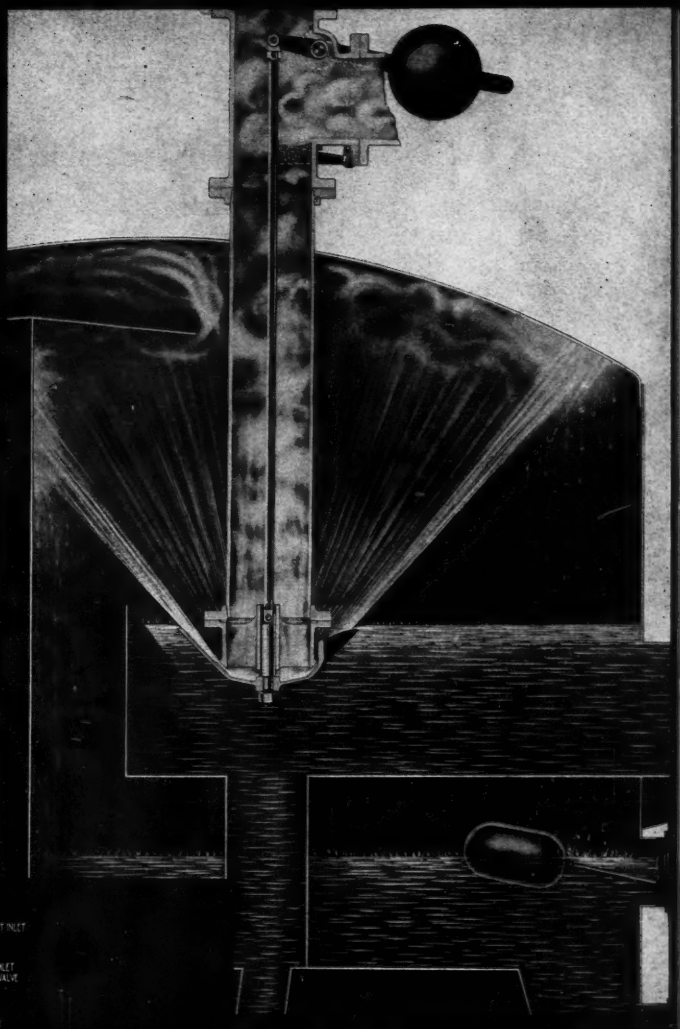
The advantages are apparent:

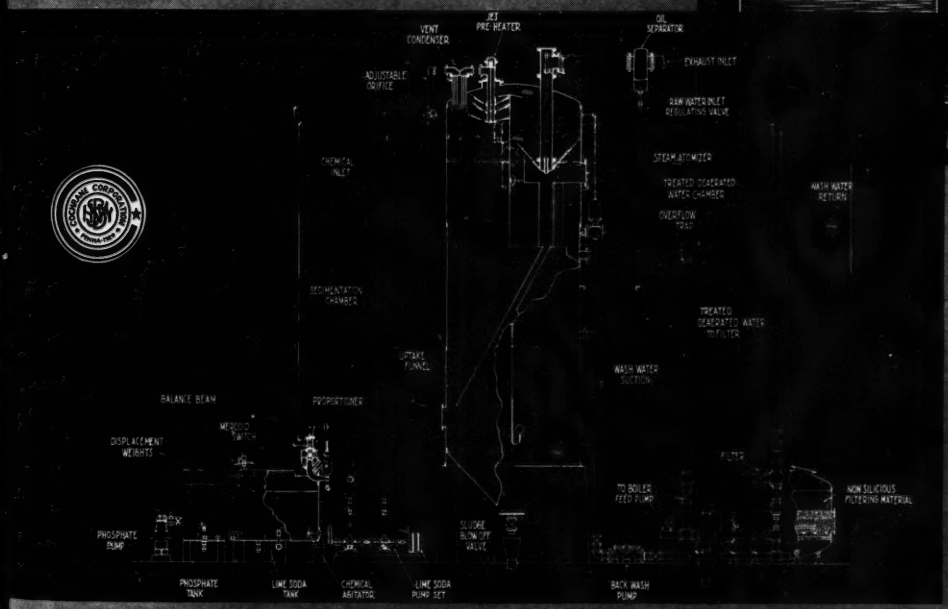
1—*A separate deaerator unit beyond the softener is eliminated.*

2—*Low overall cost is obtained.*

3—*Head-room requirements are minimized.*

4—*Heating and deaeration are accomplished without pans or trays.*





Deaeration and softening, as well as heating, are complete, affording protection to boilers, economizers, feed piping, etc., in accordance with the rigid requirements of modern boiler plant standards.

The diagram at the left illustrates equipment for 100% make-up water. Designs are available for any percentage of make-up and condensate.

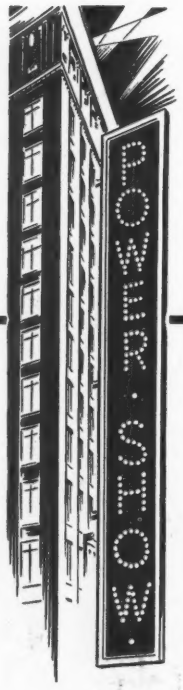
Write for Bulletin 2059.

COCHRANE CORPORATION • 17th & Allegheny Ave., Philadelphia, Pa.

COCHRANE

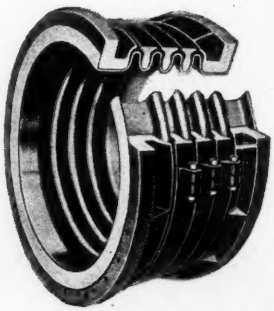
WATER SOFTENERS • DEAERATING HEATERS • FILTERS • BLOW-DOWN EQUIPMENT • VALVES • FLOW METERS

SEEING IS BELIEVING!



DIRECTED FLEXING
IN THE BADGER EXPANSION JOINT
ACTUALLY DEMONSTRATED

Flanged end joints are made of both special deoxidized copper and stainless steel; welding end joints in copper only. Full range of sizes in each line.



DIRECTED FLEXING is probably the most important of the many improvements in the corrugated type of expansion joint brought out by engineers of E. B. Badger & Sons Co. It makes the joint function better and greatly prolongs its life, as accelerated factory tests under actual working conditions and field service have proven.

So far you have heard the theory of DIRECTED FLEXING—how it progressively controls the flexing movement at all times—how it keeps flexing stresses distributed. It has been sketched. It has been explained. NOW you will be able to actually see it working.

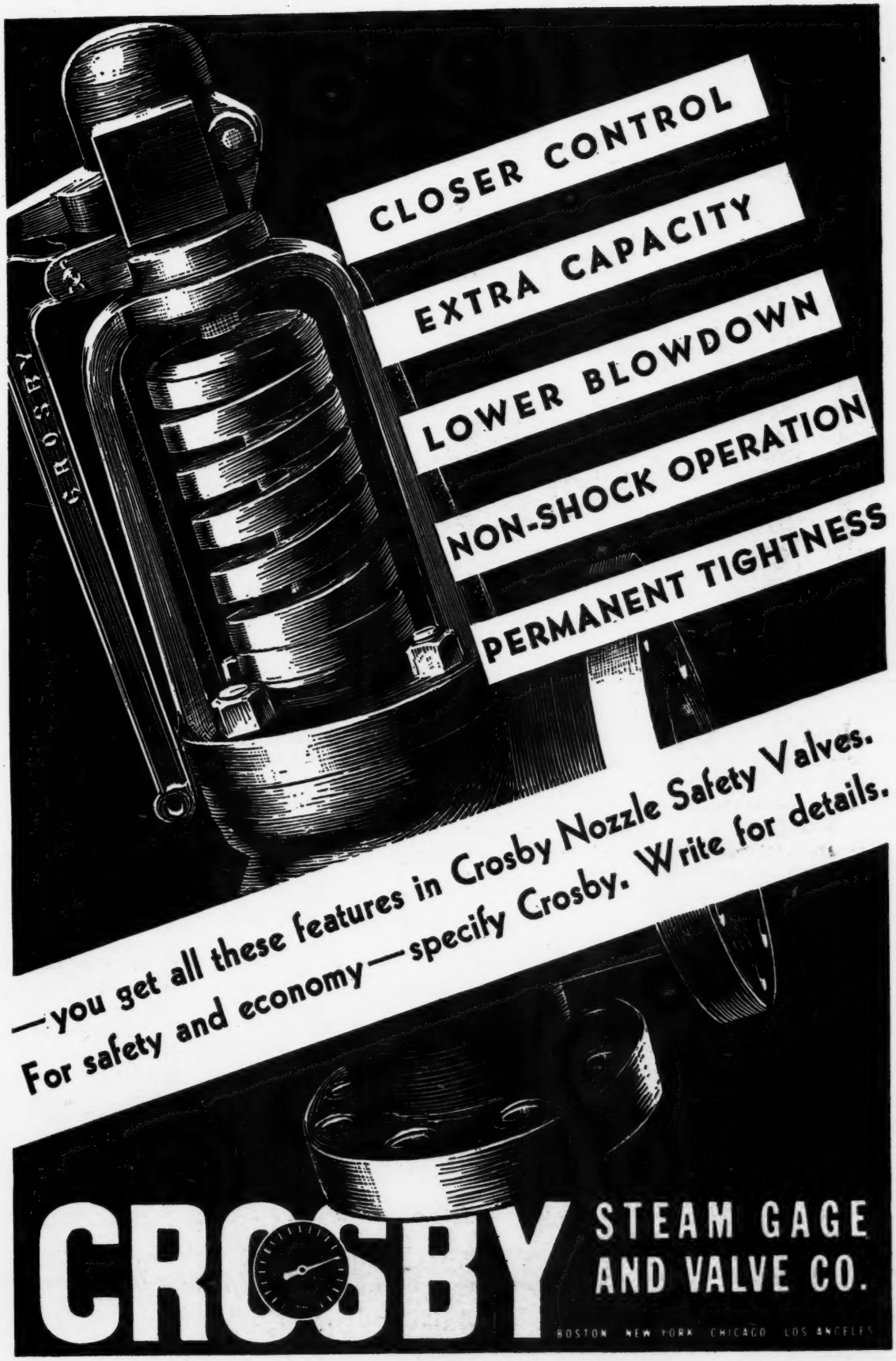
At the New York Power Show (Booth 88, Main Floor) we are going to demonstrate the principle of DIRECTED FLEXING. We are going to exhibit a section of a standard Badger joint so that you can see the movement. Once you see this demonstration of DIRECTED FLEXING you will appreciate why joints made by E. B. Badger & Sons Co. are the superior joints. These are the joints you will want to buy.

DIRECTED FLEXING—exclusive with joints made by E. B. Badger & Sons Co.—is applied to all Badger Copper and Stainless Steel Self-Equalizing Joints. The all-curve corrugation which is part of the DIRECTED FLEXING feature is also used on some low pressure and vibration-absorbing Badger Joints.

E. B. BADGER & SONS COMPANY, 71 Pitts Street, Boston, Mass.

Agents in Principal Cities

BADGER EXPANSION JOINTS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CLOSER CONTROL
EXTRA CAPACITY
LOWER BLOWDOWN
NON-SHOCK OPERATION
PERMANENT TIGHTNESS
—you get all these features in Crosby Nozzle Safety Valves.
For safety and economy—specify Crosby. Write for details.
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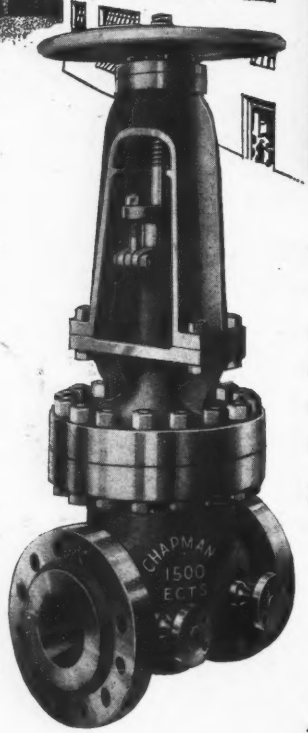
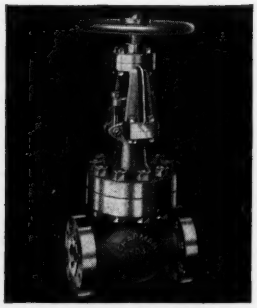
BOSTON NEW YORK CHICAGO LOS ANGELES

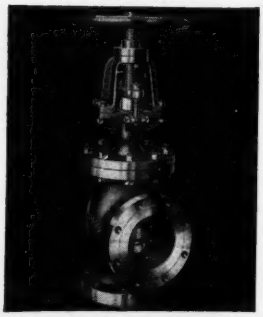
CHAPMAN VALVES

FOR EVERY POWER PLANT SERVICE





List 903 Steel Globe Valve, 900 lb. steam or hot oil—1650 lb. oil, water, gas. 1000 degrees total temperature.



List 904 Steel Angle Globe Valve, 900 lb. steam or hot oil—1650 lb. water, oil, gas. 1000 degrees total temperature.

List 601 Steel Check Valve, for 600 lb. working pressure, steam or hot oil—1200 lb. working pressure, water, oil, or gas.

To give you valves that are long-lived under "killing" conditions of temperature and pressure, Chapman has designed all styles—in all steels—that can be required in any department of power-plant operation. To these valves, there are no such things as "tough jobs."

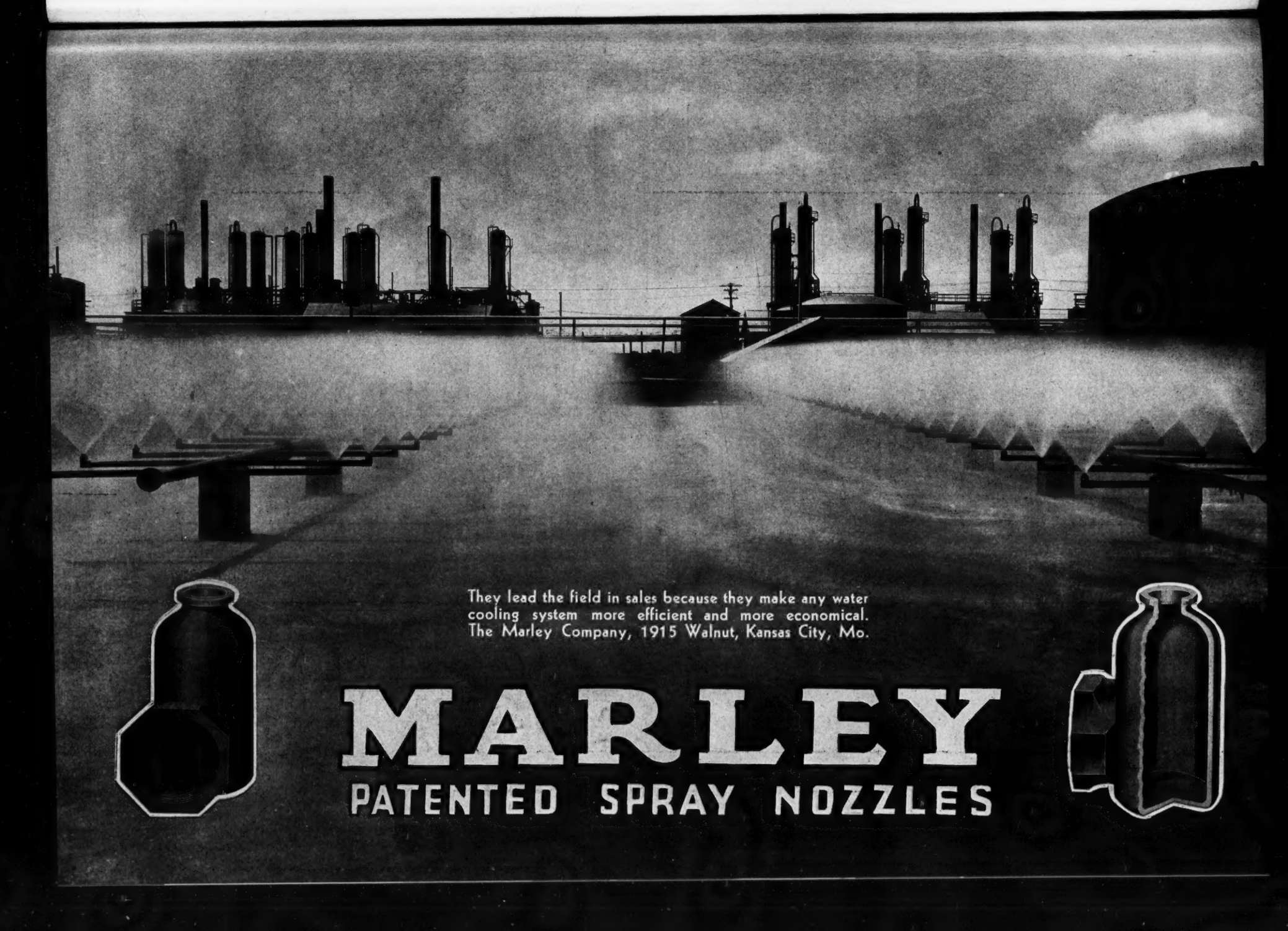
For they are built of special alloys poured in Chapman's own foundries under exact metallurgical control . . . are machined to decimals of accuracy . . . assuring long years of trouble-free service.

Chapman's complete line includes cast and forged steel gate, globe and check valves—with fittings—in the different steels listed. For pressures from 150 to 1500 lb. . . . temperatures to 1000°F. And also—standard iron and bronze gate and check valves . . . sluice gates . . . hydrants. Catalog for the asking. Write.

CHAPMAN STEEL VALVES ARE MADE IN THESE ALLOYS

- Cast Carbon Steel
- Cast Carbon Molybdenum Steel
- Cast Chrome Nickel Steel
- Cast Chrome Nickel Tungsten Steel
- Cast Nickel Steel
- Forged Carbon Steel
- Forged Chrome Tungsten Steel

The **CHAPMAN VALVE**
MANUFACTURING COMPANY
INDIAN ORCHARD, MASSACHUSETTS


They lead the field in sales because they make any water cooling system more efficient and more economical. The Marley Company, 1915 Walnut, Kansas City, Mo.
MARLEY
PATENTED SPRAY NOZZLES

YOUR BOILERS *deserve these "Life and Property Protection Valves"*

Follow the lead of large steel companies and many other industrial plants which obtain maximum safety and certain action in every emergency by equipping their boilers with Golden-Anderson Automatic Double Cushioned Triple Acting and Non Return Valves.

—These G-A Valves automatically cut out the boiler the instant a tube ruptures or other break occurs.

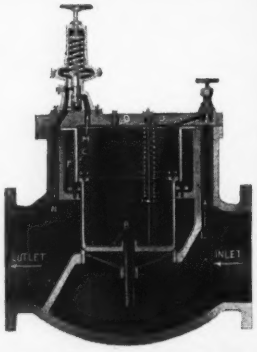
—Automatically cut off the steam flow from every boiler the instant a steam pipe breaks.

—Automatically equalize the pressure between boilers.

—Positively prevent backflow of steam into a cold boiler.

GOLDEN ANDERSON

A PRESSURE REDUCING VALVE that *"Can take it"*



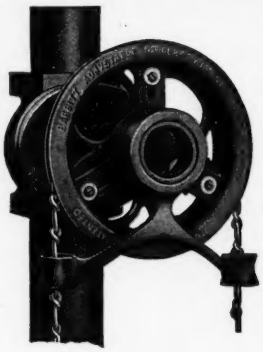
Built double extra heavy throughout, the Golden-Anderson Automatic Cushioned Pressure Reducing Valve will give long, trouble-free service on steam, air or gas lines.

Adjustment for any desired delivery pressure is quickly and easily made. Cushioning at all times prevents any chattering or pounding and the correct mechanical design overcomes wire-drawing. Fully described in latest G-A catalog.

Golden-Anderson Valve Specialty Co.
1316 Fulton Bldg., Pittsburgh, Pa.

Send for New Catalog
Concise G-A Valve descriptions enable you to choose among a large number of types for many purposes

For All "HIGH-UP" VALVES



Every overhead valve in your plant should have the easy, safe, instant control from the floor which Babbitt Sprocket Rims provide. . . . Babbitt Rims are low in cost; quickly attached; they save time, steam and accidents. Install them now. Write for descriptive folder.

BABBITT STEAM SPECIALTY CO.
New Bedford, Mass., U. S. A.

Babbitt
—Adjustable—
SPROCKET RIM
with Chain Guide

ADSCO INTERNALLY GUIDED JOINT

See our Exhibit at New York Power Show, Nov. 30-Dec. 5th

Unique Internal Guide provides full guiding without contact of polished sliding surface of slip with other working parts. Largest diameter of joint is the flange. Excess slip travel prevented by limit stops. Write for Bulletin No. 35-30PE.

AMERICAN DISTRICT STEAM COMPANY
NORTH TONAWANDA N.Y.
OVER FIFTY YEARS IN BUSINESS

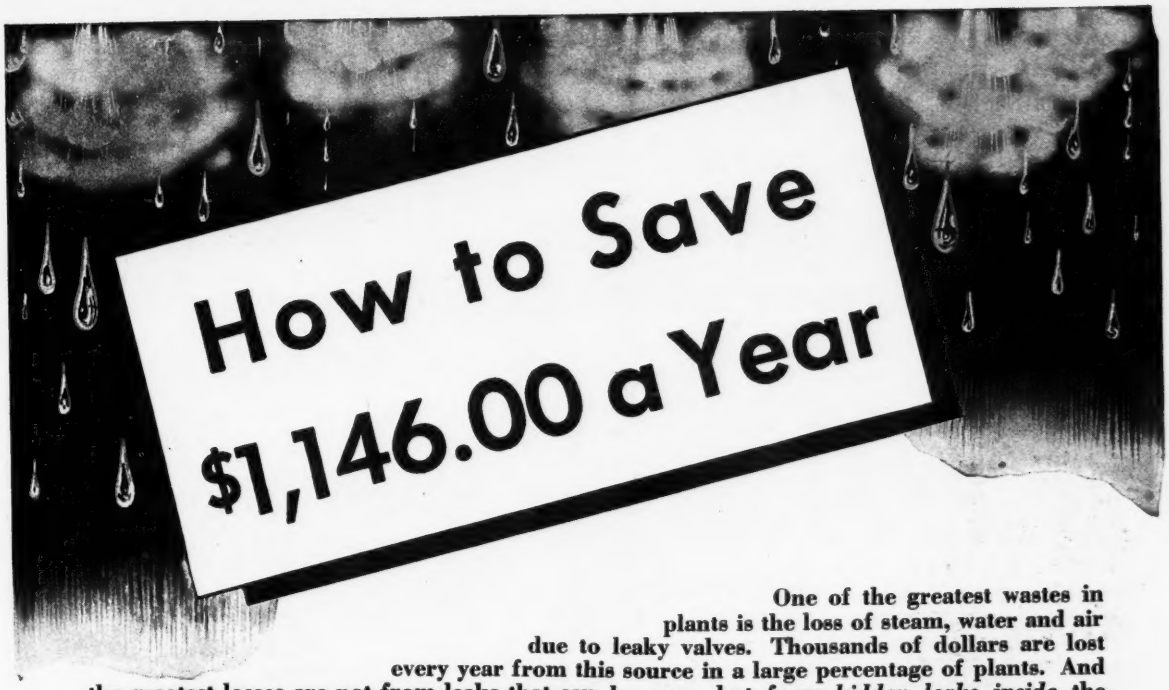
A REAL TRAP—

TYPE C
INDUSTRIAL TRAP

Cannot freeze—
(Can be placed right out in the weather)—
Cannot air-bind—
Is never water-logged—
Intermittent discharge—
Largest water and air discharging capacity of any trap on the market—
Moderate in price—
Sent on trial—Bulletin No. 535.

OTHER PRODUCTS—Stainless Steel and Steel Floats, Three and Four-Way Valves, Piston and Weight Operated Traps, Flexible Couplings, etc.

W. H. NICHOLSON & COMPANY
160 Oregon Street **Wilkes-Barre, Pa.**

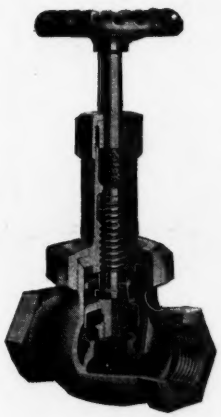


One of the greatest wastes in plants is the loss of steam, water and air due to leaky valves. Thousands of dollars are lost every year from this source in a large percentage of plants. And the greatest losses are not from leaks that can be seen, but from *hidden leaks inside* the valves.

A leak in a steam valve having an area equal to 1/32″ diameter will waste 3,175 lbs. of steam per month at 100 lbs. pressure. At a cost of 60c per thousand lbs., that is a direct loss in dollars and cents of $1.91 per valve per month—$1,146.00 per year for 50 valves. The monthly loss due to a leak 1/32″ in diameter in a hot water line is $1.31 and in an air valve having the same 1/32″ diameter area, $6.96.

Why not examine your valves now and find out how many are leaking? You'll probably be astounded at the money they are wasting.

The reason for so many wasteful, leaky valves in most plants is that ordinary valves are hard to repair. But renewals can be made so easily that you don't mind repairing Fairbanks Renewable Valves.



Take the U-01 Bronze Globe Valve shown, for instance. The asbestos disc ring can be renewed in a few minutes without removing the valve from the line.

The large hexes on union nut provide a firm wrench grip and permit removal of bonnet without damage. When it is replaced, perfect alignment is assured by the radial seat between the body and bonnet, which is drawn to a tight joint by the union nut without any sliding or scraping of the seating surfaces.

Packing in the stuffing box also can be renewed while under pressure, because the top seat above the threads on stem assures a tight joint.

In fact, every part of this valve subject to excessive wear can be renewed easily at small cost.

Many other time and money-saving features in Fairbanks "Renewables" are explained in Catalog 21. Write for a copy, or mail the coupon.

See our Exhibit at Booth No. 78, National Exposition of Power & Mechanical Engineering, New York, Nov. 30th to Dec. 5th.

THE FAIRBANKS COMPANY

Valves, Dart Unions, Hand Trucks and Wheelbarrows

399 Lafayette St., New York, N. Y.

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Fairbanks Renewable Valves

MAIL COUPON TODAY!

The Fairbanks Company
399 Lafayette St., New York, N. Y.

Without obligation on our part, kindly send a copy of your Catalog No. 21.

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COMPLETE
STEEL VALVE LINES
FOR MODERN POWER PLANTS

150 to 1500 lb. SP

Gate - Globe
Check - Non-return
and Blow-off

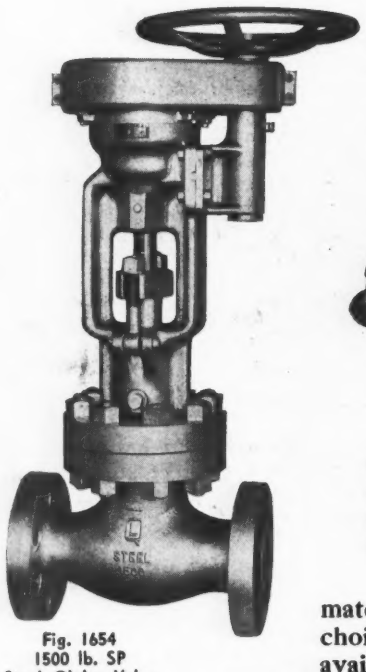


Fig. 1654
1500 lb. SP
Steel Globe Valve
with Gearing

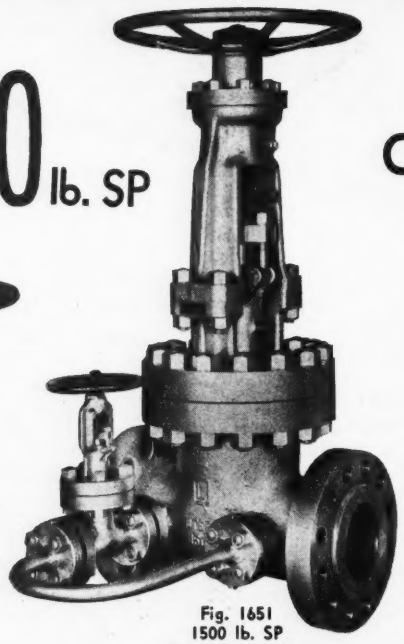


Fig. 1651
1500 lb. SP
Steel Gate Valve
with By-pass

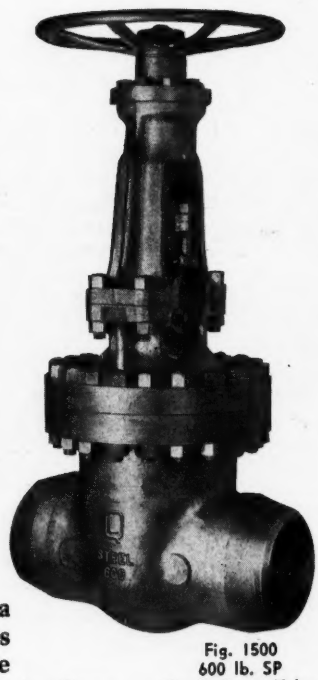


Fig. 1500
600 lb. SP
Steel Gate Valve
with Welding Ends

Lunkenheimer Steel Valves are designed in a variety of types and sizes and for all prevailing pressures and temperatures required by Modern Power Plants.

As no one combination of materials is suitable for all conditions, a choice of materials as well as types is available. Bodies and bonnets may be made of carbon or alloy steels, and trimmings of various alloys selected to suit the installation. Valves may be constructed for flanged or welded piping and equipped with motor control or gearing.

The Lunkenheimer Company is prepared to assist you in power plant valve problems. Write for information.

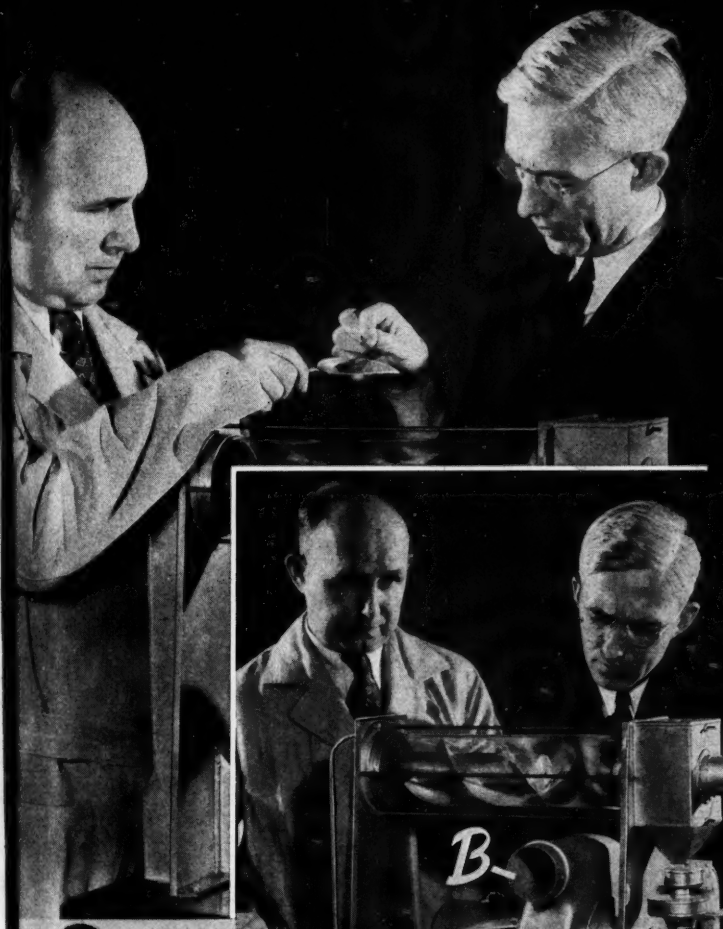
See our exhibit at the POWER SHOW—Booth No. 52

THE LUNKENHEIMER CO.
"QUALITY"
CINCINNATI, OHIO, U. S. A.
NEW YORK CHICAGO BOSTON
PHILADELPHIA SAN FRANCISCO
EXPORT DEPT. 318-322 HUDSON ST., NEW YORK

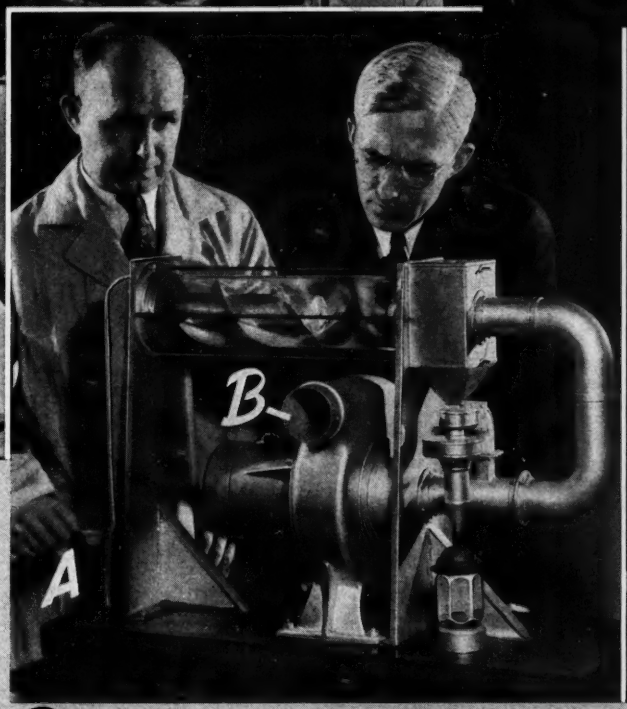
BOILER MOUNTINGS — LUNKENHEIMER VALVES — LUBRICATING DEVICES

15-67B-44

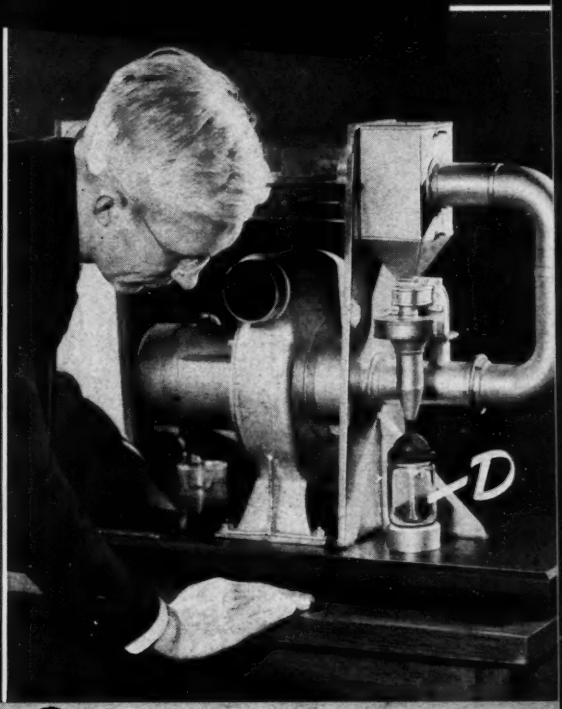
UNIQUE DEMONSTRATION *Illustrates* PRINCIPLE OF SIROCCO ST DUST COLLECTOR



1 H. O. Danz, head of the Dust Collector Division American Blower (left, top photo) and Plant Engineer Wilson examine a scoop of dust before it is run through a test model of an American Blower type ST dust collector.



2 Candid camera shot of collector in action. Dust is introduced in air inlet (lower left hand corner A). A split second later it is seen concentrated at the outside of the glass tube and following a spiral path to the point of entry to dust chamber. The cleansed air at the center of the glass tube is discharged through outlet B. Note the absence of dust at the fan discharge outlet (B). This unusual action photograph demonstrates the practicability and simplicity (no moving parts) of the American Blower Sirocco type ST collector.



3 After demonstration Plant Engineer Wilson inspects the dust collected (dust chamber D). The spontaneous action, simplicity and performance of this dry compact collector appeals to power plant engineers who are seeking a practical and effective means for collecting fly ash.

WE'LL BE THERE. American Blower Dust Collectors will be displayed at the Power Show, Grand Central Palace, New York City. American Blower Engineers well versed in dust problems . . . men that talk your language . . . will be there to give you complete information without obligation or charge. If for any reason you cannot attend the show and want this same service, mail the coupon or phone the nearest American Blower branch office.

See the American Blower Exhibit, Booth 72

See this and other
AMERICAN BLOWER DUST COLLECTORS
at the
POWER SHOW
GRAND CENTRAL PALACE,
NEW YORK CITY
November 30th to
December 5th

AMERICAN BLOWER CORPORATION
6000 RUSSELL ST. • DETROIT, MICHIGAN
Division of American Radiator and Standard Sanitary Corp.

AMERICAN BLOWER CORP.
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Send dust collector bulletin to
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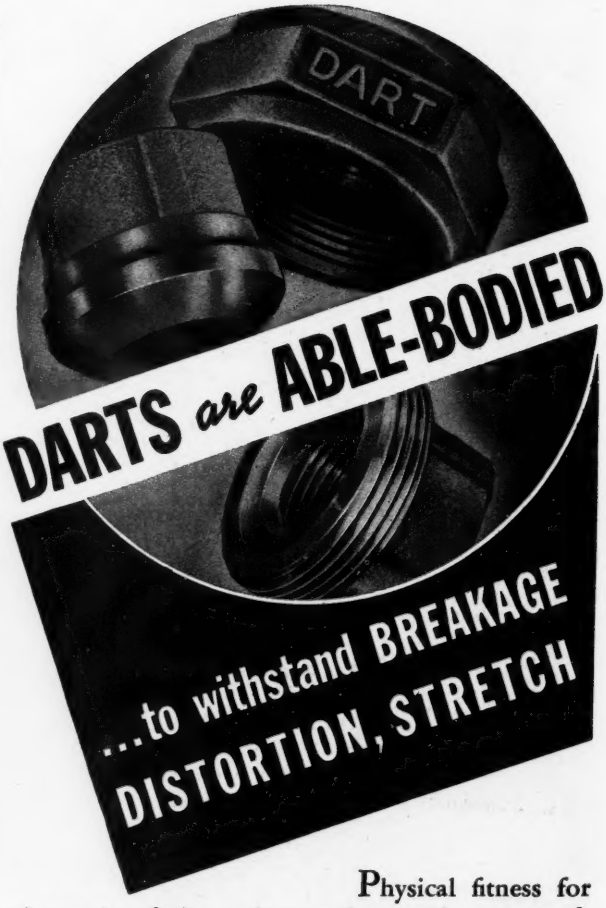
THE only complete small steam trap—Super-Silvertop No. 10 leads the field after being on the market only three months (following one year in the laboratory and two years in the field). Users of small steam traps needed a trap that was positive in action, one that would keep steam units drained dry. Being an inverted bucket trap, Super-Silvertop No. 10 meets this need. It has all the advantages of the larger Super-Silvertop traps, but its size and price make its use feasible for *any* job requiring a small trap. Super-Silvertop No. 10 puts an end to parts replacement, its inverted bucket will not collapse or leak regardless of pressure. It has the same pipe connections as thermostatic traps, which means that it can replace thermostatic traps without change of piping. For pressures from 0 to 125 pounds. Write for table of capacities and other information.

THE V. D. ANDERSON COMPANY
1939 West 96th Street • Cleveland, Ohio



Physical fitness for the strain of pipe union service requires a sound, rugged body. So Dart uses a special grade of iron that is especially suited to the purpose. Both pipe ends and nut are made from air-refined malleable of high tensile strength and yield point, with a lower percentage of elongation than steel. Practically unbreakable, Dart bodies also have exceptional resistance to thread-distortion.

And into these stout iron bodies are swaged Dart's *two bronze seats,* spherically ground to a true ball joint that stays tight-sealed no matter how often disconnected and re-installed. No other union gives you these features.

In fact, no other union can give you such economy in service . . . and you can prove that for yourself. Write today for free test union in either black or galvanized finish.

DART
UNIONS

E. M. DART MFG. CO., PROVIDENCE, R. I.

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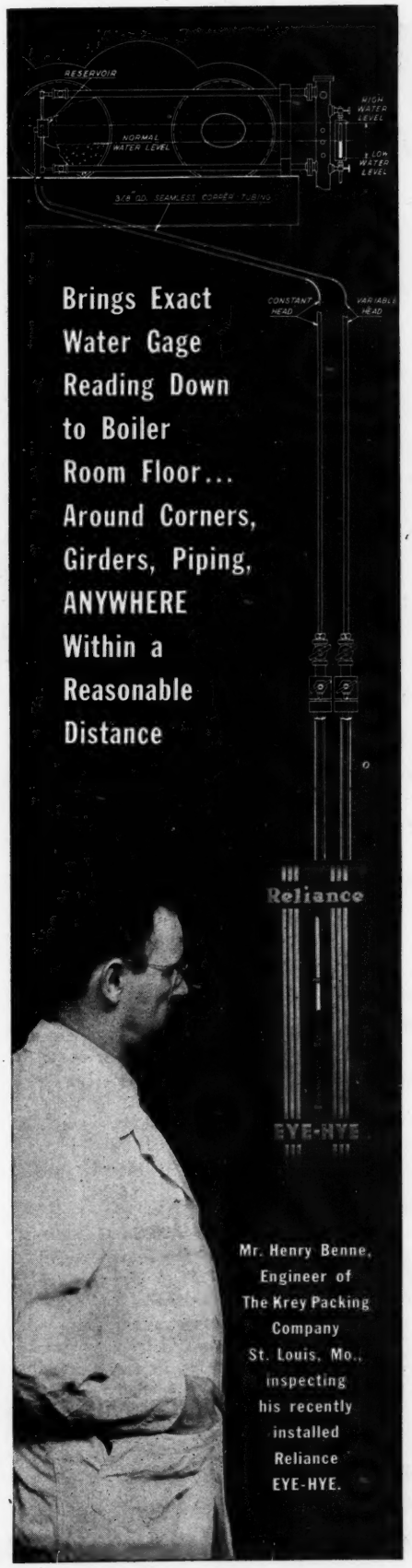
RESERVOIR
HIGH WATER LEVEL
NORMAL WATER LEVEL
LOW WATER LEVEL
CONSTANT HEAD
VARIABLE HEAD
Brings Exact Water Gage Reading Down to Boiler Room Floor... Around Corners, Girders, Piping, ANYWHERE Within a Reasonable Distance
Reliance
EYE-HYE
Mr. Henry Benne, Engineer of The Krey Packing Company St. Louis, Mo., inspecting his recently installed Reliance EYE-HYE.

EYE-HYE

The Remarkable New Reliance Remote-Reading Water Level Gage

It brings an exact reading of your boiler water gage right down to clear convenient eye height.

It brings it down anywhere you want it.

It shows the precise level of the water in the boiler as a bright green liquid, sharply illuminated.

It is accurate and stays accurate. Nothing to get out of order, it is trouble-free. Months of stringent tests have proved its dependability.

It is one of the finest of a long line of fine boiler equipment developed by Reliance engineers. It carries the Reliance assurance of satisfaction.

If your water gages are high up on the boilers, obscured by piping or structure, subject to frequent coating with dirt—if for any reason they're not quick and easy to see, EYE-HYE is what you've been looking for.

See the new Reliance EYE-HYE at our booth at the New York Power Show—or write for complete information.

THE RELIANCE GAUGE COLUMN CO.

5932 Carnegie Ave., Cleveland, Ohio

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BOILER ALARMS and GAGES

SUPER-SEAL
TRADE MARK
PLASTIC PACKING

DRY GRAPHITIZED
Thru and Thru!

Every strand of the long fibre asbestos used in SUPER-SEAL is thoroughly graphitized—the graphite impregnates every fibre thru and thru—assuring a permanent dry lubrication at the wearing face. Present day high speed equipment under high temperatures and high pressures demand this type of packing.

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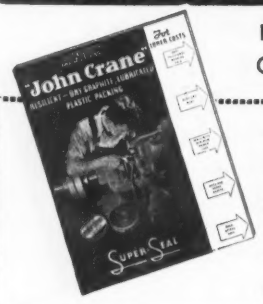

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Please send SUPER-SEAL bulletin.

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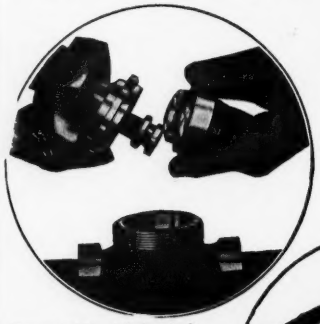
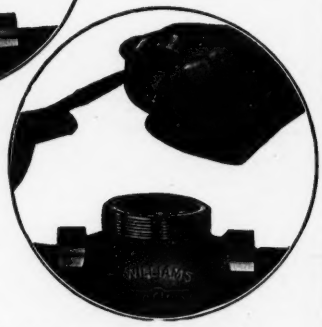
Use **VULCODISC**

for trouble-free valve jobs



In renewing the disc, note how easily and quickly the Vulcodisc Jiffy Disc Holder slips off the stem head. Only the disc lock nut to remove and the old disc is off and replaced in a jiffy.



Dense without being brittle—tough, yet resilient, Vulsodisc will not swell, warp or soften — in fact its absorption is less than 1 per cent. . . That is why an old Vulcodisc comes out of the disc holder as easily as a new one goes in. No need for hammer and chisel to cut the disc out in pieces—distorting and disfiguring the holder. Write for descriptive bulletin.

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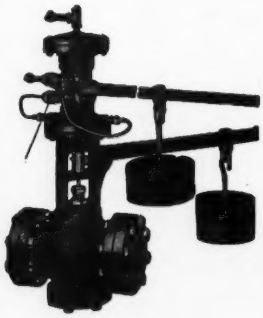
Cincinnati, Ohio

Water Will Flow Either Way to Maintain the Tank Level

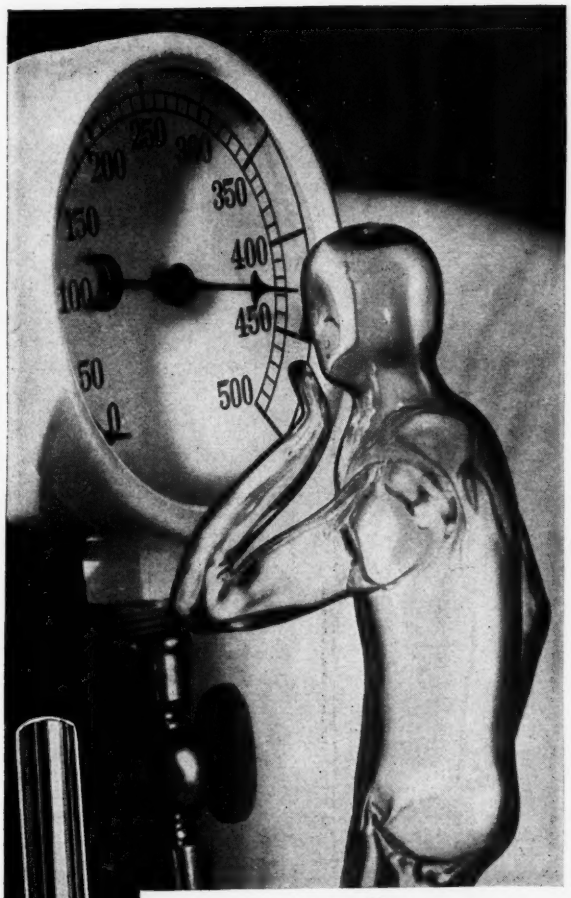


CF

Altitude Governor

IF pump pressure is greater at a given moment, flow will be upward to the tank. If tank pressure is greater, flow will be downward through the same line till this emergency condition is relieved. Full flow in either direction is permitted by the Fulton Tank or Altitude Governor, its function under normal conditions being to keep inlet and outlet under balanced control and water in the elevated tank at proper level, for economy and safety. Descriptive circular will be mailed on request.

THE CHAPLIN-FULTON MFG. CO.
28-40 Penn Ave. Pittsburgh, Pa.



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"Pyrex" GAUGE GLASSES

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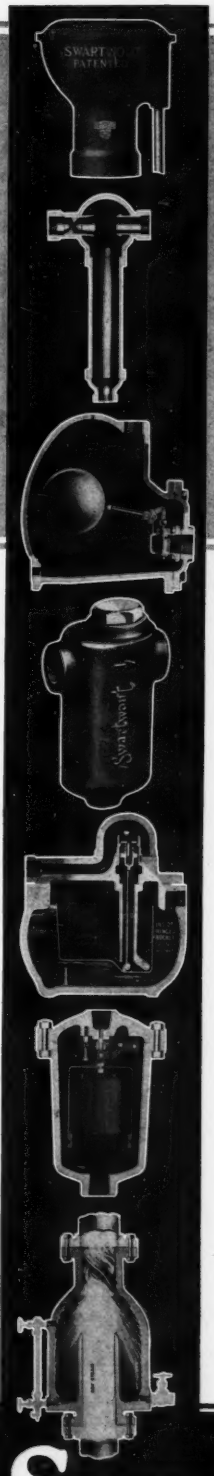

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Solving vexing problems of Power Plant economy and efficiency, and meeting the most exacting service conditions for a period of 32 years — is the dependable record of Swartwout Power Plant Equipment.

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STEAM TRAPS
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LIQUID LEVEL CONTROLS
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DRAINAGE CONTROLS
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OR SEDIMENT TRAPS
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The Swartwout Company
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Cleveland Ohio

Higher water level on heavy loads

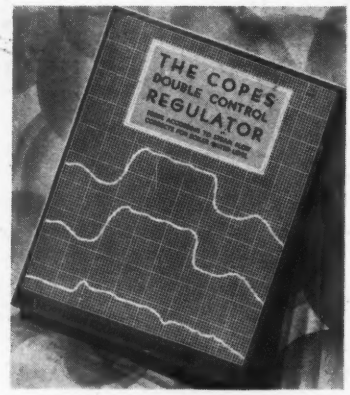
3 inches at 90%
4.5 inches at 210%

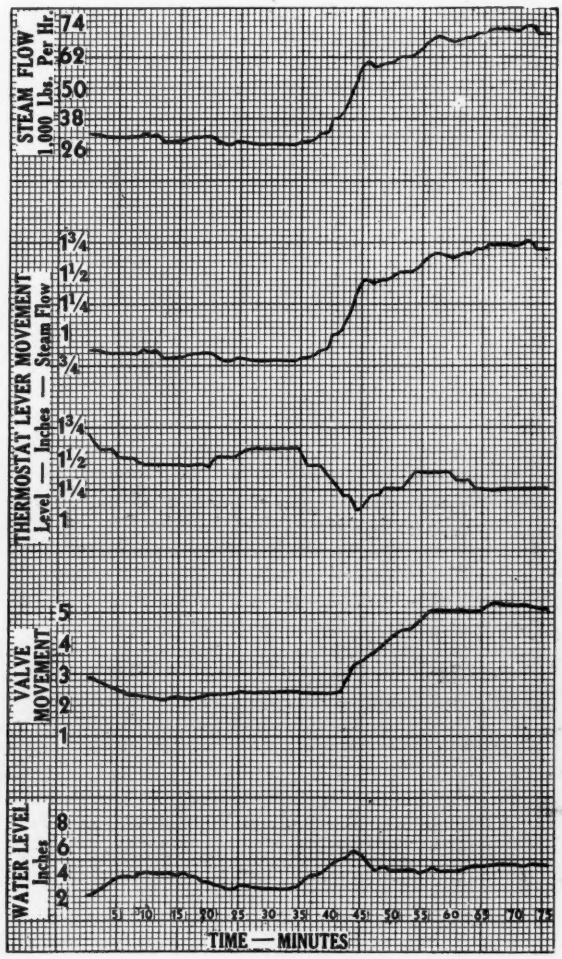
No feed water regulator can prevent the "swell" of boiler water on a sudden load increase. But the Copes Double Control Regulator dampens this effect in boilers. In most cases, it is done by carrying a higher water level on heavy loads than on light.

As in this case. The boiler is a stoker-fired 1000-horsepower Bigelow-Hornsby operated at 200 pounds W.S.P. At 73,000 pounds per hour load, the water level averages 1½ inches higher than at 31,000 pounds per hour.

The COPES Double Control Regulator feeds in response to changes in the rate of steam flow. As proof of its accuracy, note how closely the valve movement curve—there was no water meter—follows the steam flow curve on this chart.

If you want a higher boiler water level on heavy loads than on light or a more stabilized water level on all loads—investigate COPES Double Control. You'll like the results it is giving.





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This chart is from one of six installations discussed in this interesting new booklet. Illustrated with performance charts and operating diagrams. Many helpful facts on boiler water level control. Write today for Circular 133-AE.

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FEED WATER REGULATORS - DIFFERENTIAL VALVES - PUMP GOVERNORS - CONDENSATE DRAINAGE AND LIQUID LEVEL CONTROLS - BALANCED FLOAT MOTOR THRUSTOR AND PRESSURE REDUCING VALVES

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SYSTEM OF BOILER FEED CONTROL

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You can't beat the Women

FOR FINDING THE FAULTS..

Foreman Bennett, 48 years with Jenkins, isn't going to let the women upstairs get any faulty work from his department.

Machinist Joe Brown, 42 years with Jenkins, doesn't intend to have any doubtful work chalked-up against his record.

IT'S A FACT that women are keener at finding faults than men. So when you enter Jenkins Inspection Room you meet the "fair sex"... a specially trained group of the best fault-finders we can hire. It takes a perfect valve part to get by them, and into the Assembly Department. For Jenkins multiplies their effectiveness through a *safeguarded* inspection system.

The first safeguard is specialization. Each inspector gives undivided attention to a specific detail. The second is *salaried* inspectors, never driven by piece-work or bonus schedules. They can take all the time they want to dust, scrape, dig and measure in their search for faults.

Third, and most important safeguard is elimination of "errors in judgement." Jenkins' inspectors do not attempt to decide between good and bad. They merely set aside parts not obviously perfect. Anything that even looks suspicious can be judged only by Chief Inspector Lyddy, whose decisions are backed by 50 years experience.

This formal inspection is only one branch of Jenkins' plant-wide fault-finding system. Before parts ever reach the Inspection Department they are carefully examined by the machinist and his Foreman. Then after assembly they go through two more inspections and service-testing. All this exhaustive trouble-shooting is done by Jenkins *first*, so customers won't need to do it afterwards. It is one of the things that makes a "Jenkins" a *lifetime service* valve, that costs less per year, even if it sometimes costs a trifle more to buy.

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Whether you need
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A 48″ Jenkins Iron Body Gate Valve operated by electric motor control.

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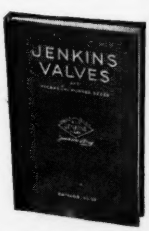
—or any size in between— you will find sound reasons for buying a "Jenkins". . .

CRITICAL examination of any Jenkins Iron Body Gate Valve reveals the benefits of Jenkins skilled craftsmanship and 70 years of specialization in the manufacture of fine valves. In every size and type are found superiorities of design and construction which provide for exceptional valve service.

Strength is emphasized in making Jenkins Iron Body Gate Valves. Out of the eighteen superior features found in a "Jenkins", nine are strength-multiplying points. From stuffing box bolts to body, a Jenkins Gate is made capable of handling ordinary duty with an ease that means longer valve life, and less maintenance work and expense. Because of this great reserve strength, it can also "carry-on", even if extraordinary strains should be encountered.

In the Jenkins Catalog you will find Iron Body Gate Valves for most any need. Sizes from 2″ to 48″, in Solid Wedge and Double Disc Parallel Seat types, and operated by motor, cylinder or special gearing arrangements.



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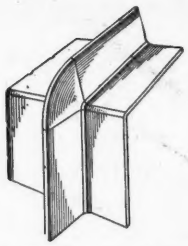

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Connery's Improved Expansion Construction for breechings, ducts, and uptakes prevents buckling, warping and collapsing. Electrically welded—Gas Tight—Moisture Proof. Connery Construction costs no more than ordinary construction.

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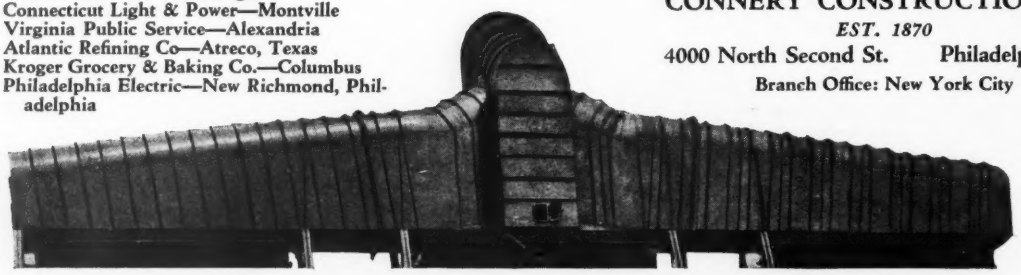

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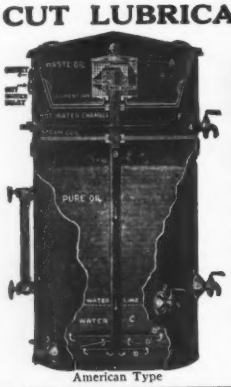

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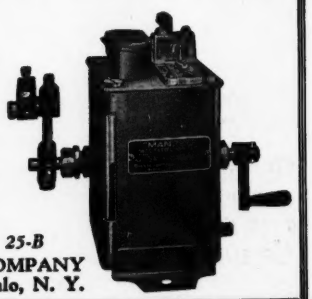

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Keeps machinery fit for steady service. Reduces oil bills 30% to 60%.

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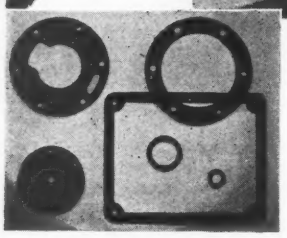

Above: GARLOCK 353 Oilblack Rubber Sheet Packing. Below: GARLOCK 953 Gaskets, cut from GARLOCK 353 Sheet.

Garlock 353
OILBLACK RUBBER SHEET

SCIENTIFICALLY compounded by GARLOCK to *resist the deteriorating action of oils*, GARLOCK 353 gives exceptionally long and dependable service against heavy and light oils. Also is recommended for hot or cold water, saturated steam, ammonia or alkali solutions. Try GARLOCK 353 in your plant; it will save you time and trouble . . . will help you keep down maintenance costs.

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GARLOCK

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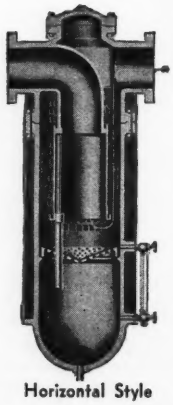

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THE economy of an efficient steam separator is continuous and an additional 1% of water removed by such a separator over one less efficient is at all times to this extent; this saving applies not only to fuel but to total cost of producing steam — fuel, labor, upkeep, depreciation, and overhead. Steam is the finished product from a boiler, therefore, a customer is justified in buying efficiency. We have a volume of evidence accumulated during forty years that Sweet's Direct Separators do just this and are a profitable investment. The above applies also to oil separators.

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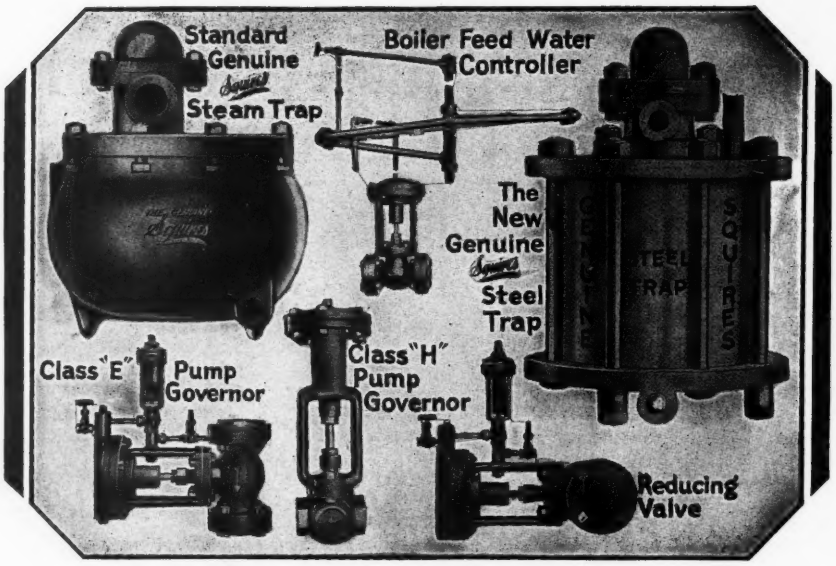
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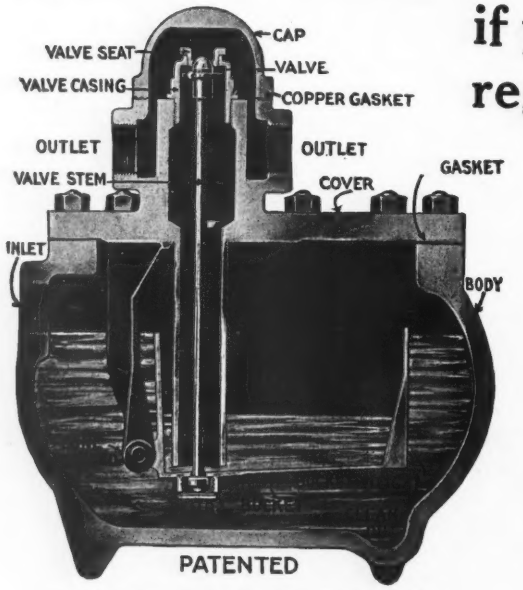

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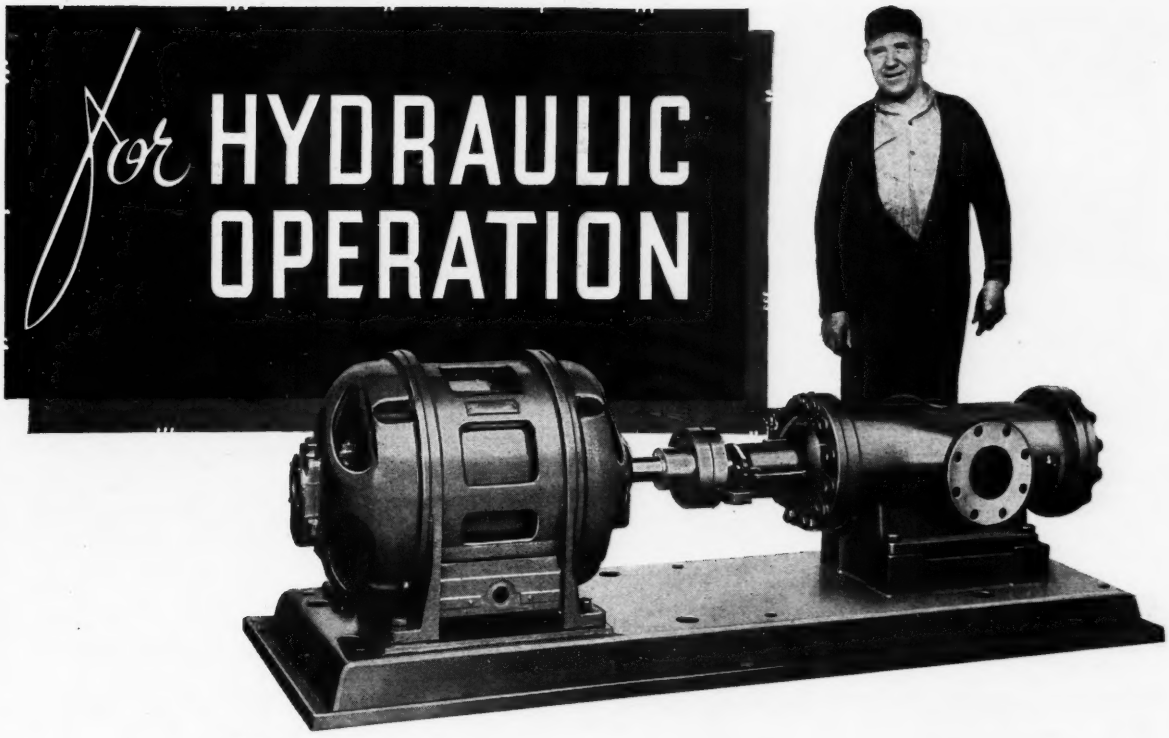

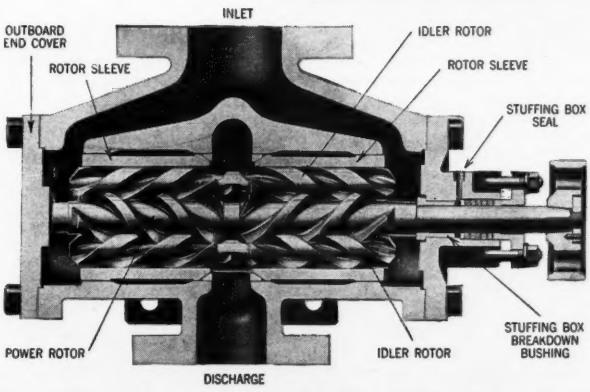

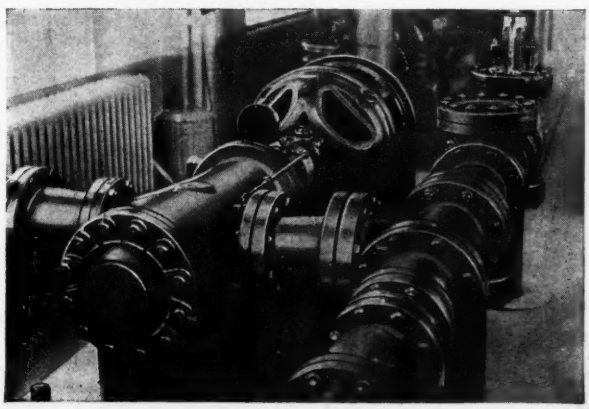

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I-16

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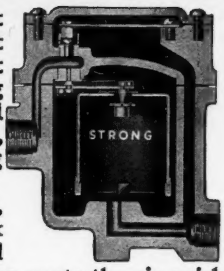

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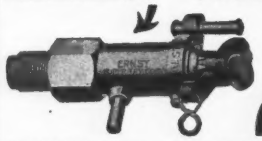

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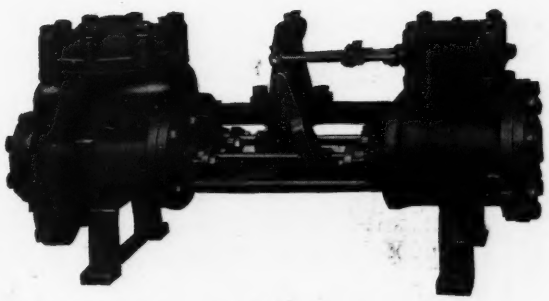

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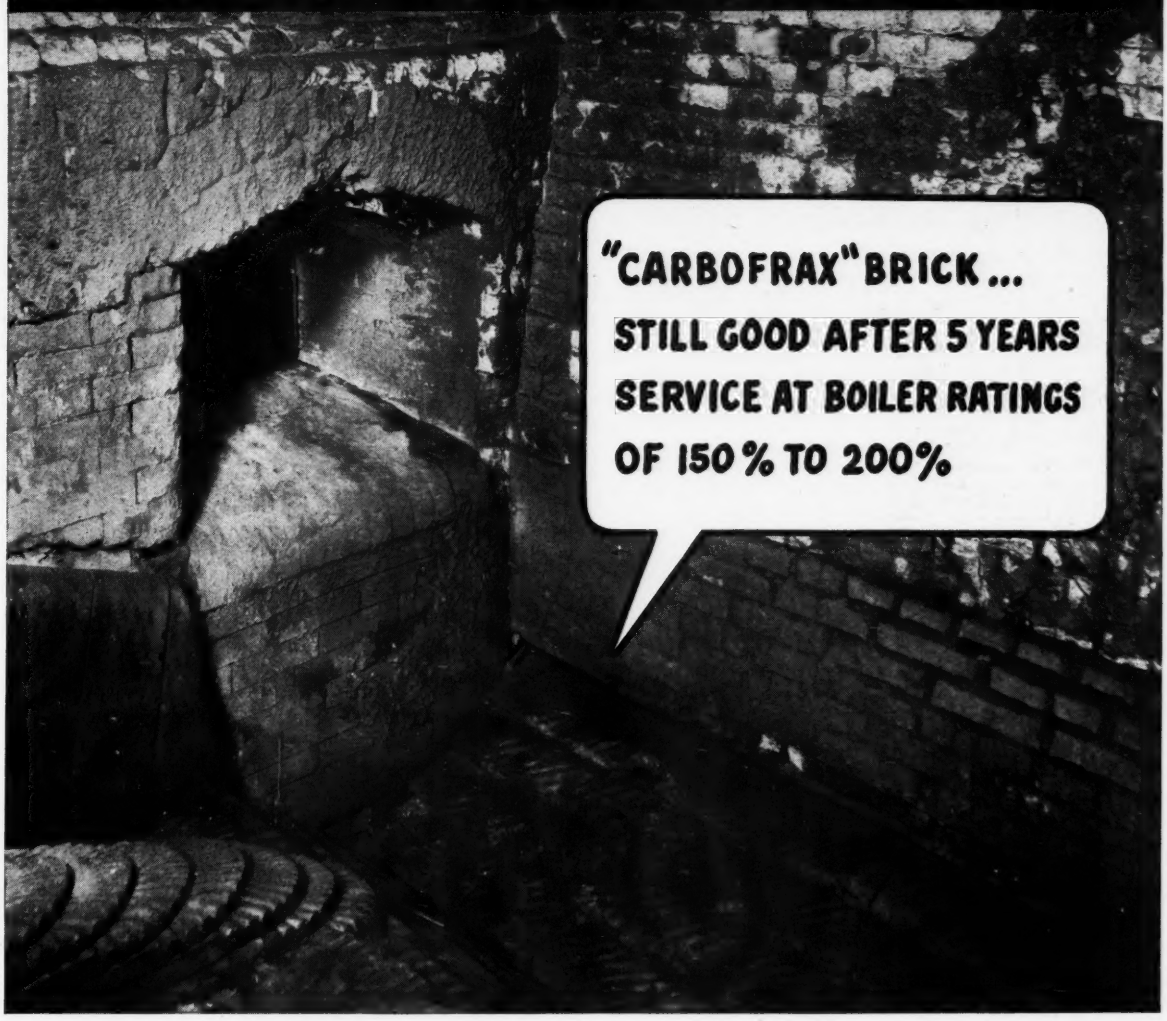

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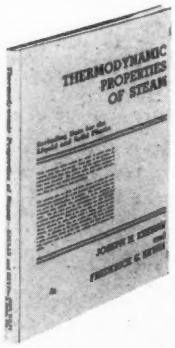

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5. Its tables include the greatest range of pressures (0 to 5500 or 6000 lb./sq. in.) and of temperatures (—40 to 1600°F.) ever covered in steam tables.

The Contents

Introduction
Bibliography
Symbols Used in Tables
Saturation: Temperatures
Saturation: Pressures
Superheated Vapor
Compressed Liquid
Saturation: Solid-Vapor
Viscosity
Heat Conductivity
Conversion Factors
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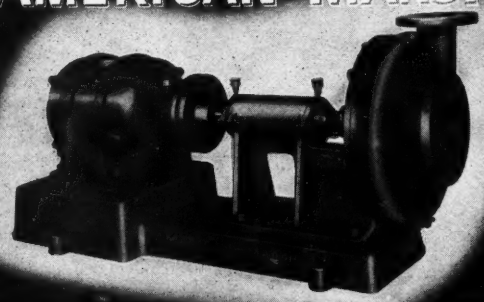

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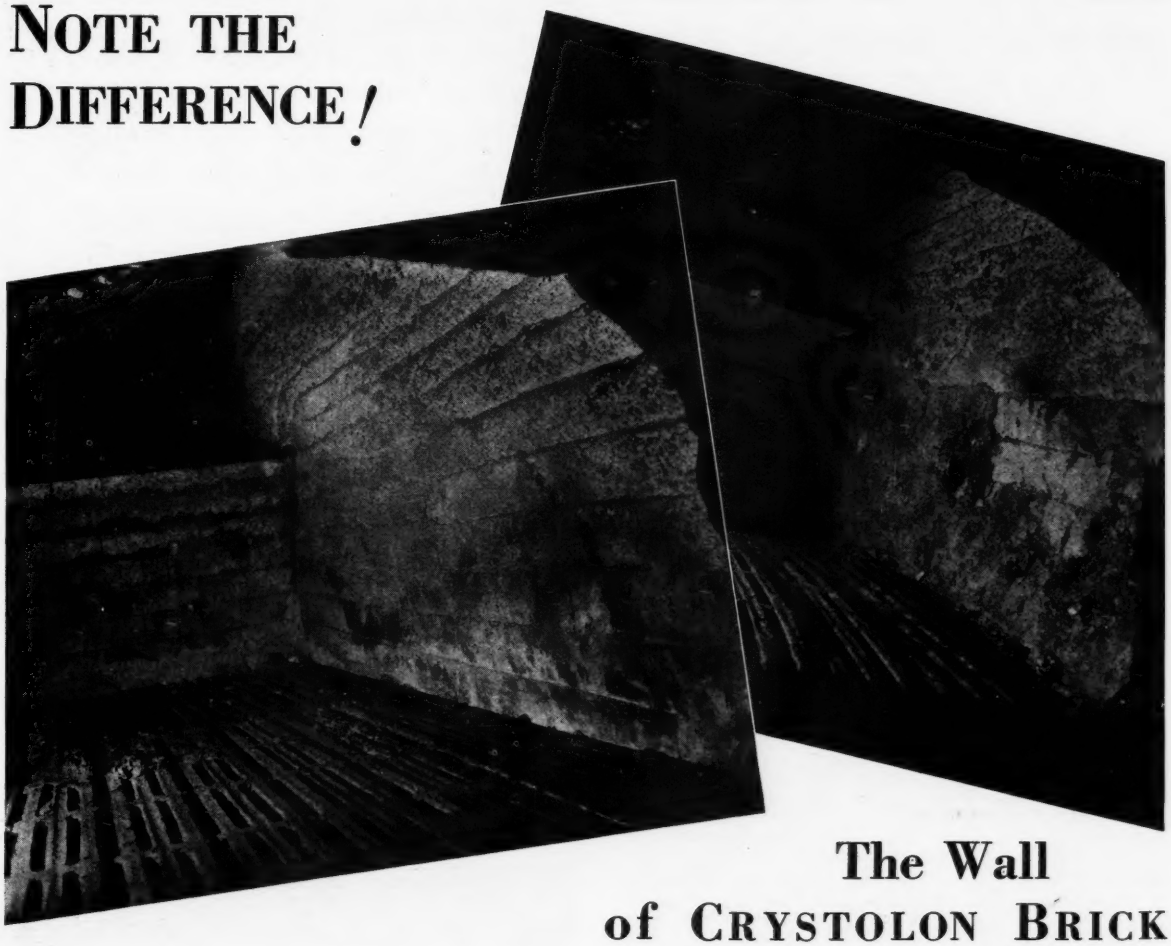

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THESE unretouched pictures show the interiors of two boiler fire boxes in a large school building. They stand side by side, using the same coal, receiving the same service. The boiler shown on the left has been lined with Crystolon Brick (silicon carbide) for several years. Contrast the condition of this brick—its freedom from clinkers and slag—with the condition of the ordinary brick in the other boiler. In your boilers, too, Crystolon Brick will reduce slag and clinker troubles, will show lower maintenance costs.

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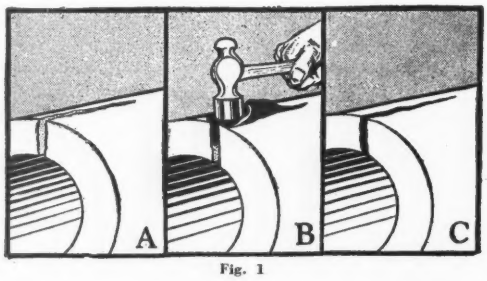

Fig. 1

be spread over and tamped in with a hammer. What spreads away should be brought back and tamped further, as continued tamping works the cement into the finest crack. Upon hardening of what has entered the crack, the repair is complete.

REINFORCED REPAIRS:—If pressure, warping, vibration or expansion from heat are apt to strain the repair, it should be reinforced. Plain metal straps (Fig. 2) fastened across the crack with screws, or around the casting with straps will give the necessary protection. A surface pocket and clamp for forcing additional Smooth-On against the crack are desirable under severe conditions, and obtainable by putting a metal patch plate under the

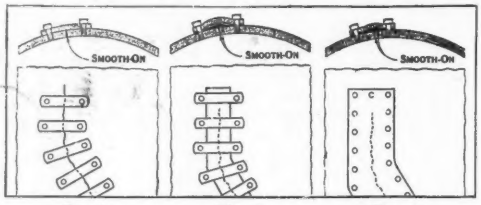

Fig. 2 Fig. 3 Fig. 4

straps (Fig. 3) or by utilizing a patch plate held at the edges by screws (Fig. 4).

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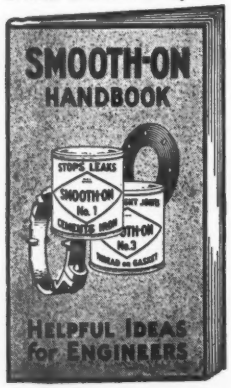

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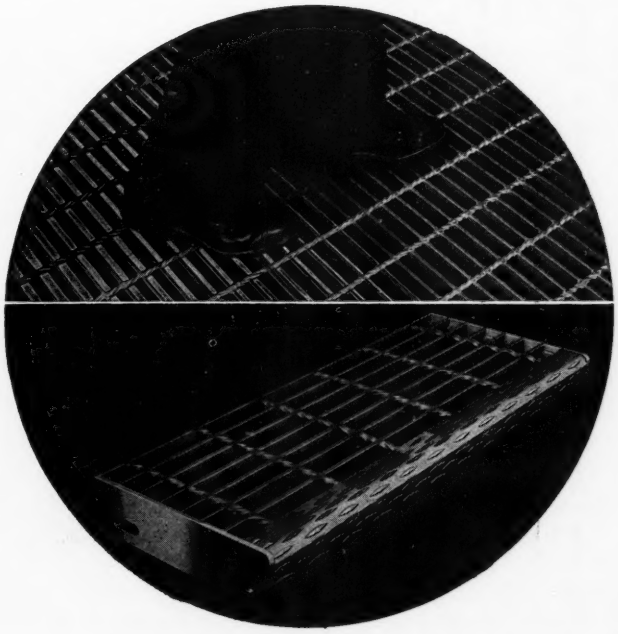

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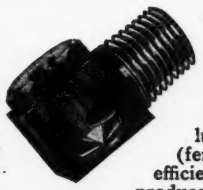
non-clogging
SPRAY NOZZLES



For Air Washing

We recommend either ⅜" Fig. 629 male pipe (illustrated) or ¼" Fig. 631 (female) Brass nozzles. Small, efficient, and inexpensive, they produce an evenly distributed hollow cone spray. One large lead hole minimizes any clogging tendency. Capacities from 4.7 G.P.H. up at 40 lbs.

For Re-Cooling

Monarch Fig. B-8 and new B-8-A cast Brass nozzles, for cooling condensing water in spray ponds, use no internal vanes or deflectors which might facilitate clogging. Available in capacities up to 76.5 G.P.M. at 10 lbs.

Write for Catalog 6-A

MONARCH MFG. WORKS, INC.
2727 E. Westmoreland Street, Philadelphia, Pa.

F&E

UNDERFEED STOKERS

BEHIND "F & E" Underfeed Stokers is the experience of stokering approximately six million boiler horsepower, boiler sizes ranging from 25 horsepower to over 500 horsepower.

Only in "F&E" Underfeed Stokers is found this combination of advanced engineering features:

1—Interval Timer Governor
2—Foolproof Against Breakdowns
3—Sliding Bottom Retort
4—Fuel Bed Control
5—Zoned Air Distribution

Write for free catalogue

FLYNN & EMRICH CO.
Established 1842
Baltimore - - - Maryland

WHEN YOU INSTALL G-E MIDGET

One of the Best Types of Production

COMPACT

Height: 64 inches
Width: 22 inches
Depth: 48 inches

MODERATE COST

The cost of the midget metal-clad compares favorably with that of switching equipment purchased and installed piecemeal.

MINIMUM INSTALLATION COST

You receive the midget metal-clad completely assembled—just set it in position and connect the cables.

BETTER APPEARANCE

Instruments and devices mounted semiflush to give streamlined appearance. Standard units without panels also available.

SAFETY

When breaker is lowered from operating position, the circuit is automatically interrupted inside the breaker. All live parts are completely enclosed in grounded steel compartments.

CONVENIENCE

Circuit breaker can be completely removed from housing in a few moments for inspection.

PROPER OPERATION

A system of interlocks prevents incorrect operation and possible damage to machines.

MOBILITY

The midget metal-clad unit can readily be moved to a new location at any time.

LOW MAINTENANCE

Silver contacts in the breaker and silver disconnecting devices minimize maintenance.

GENERAL ELECTRIC

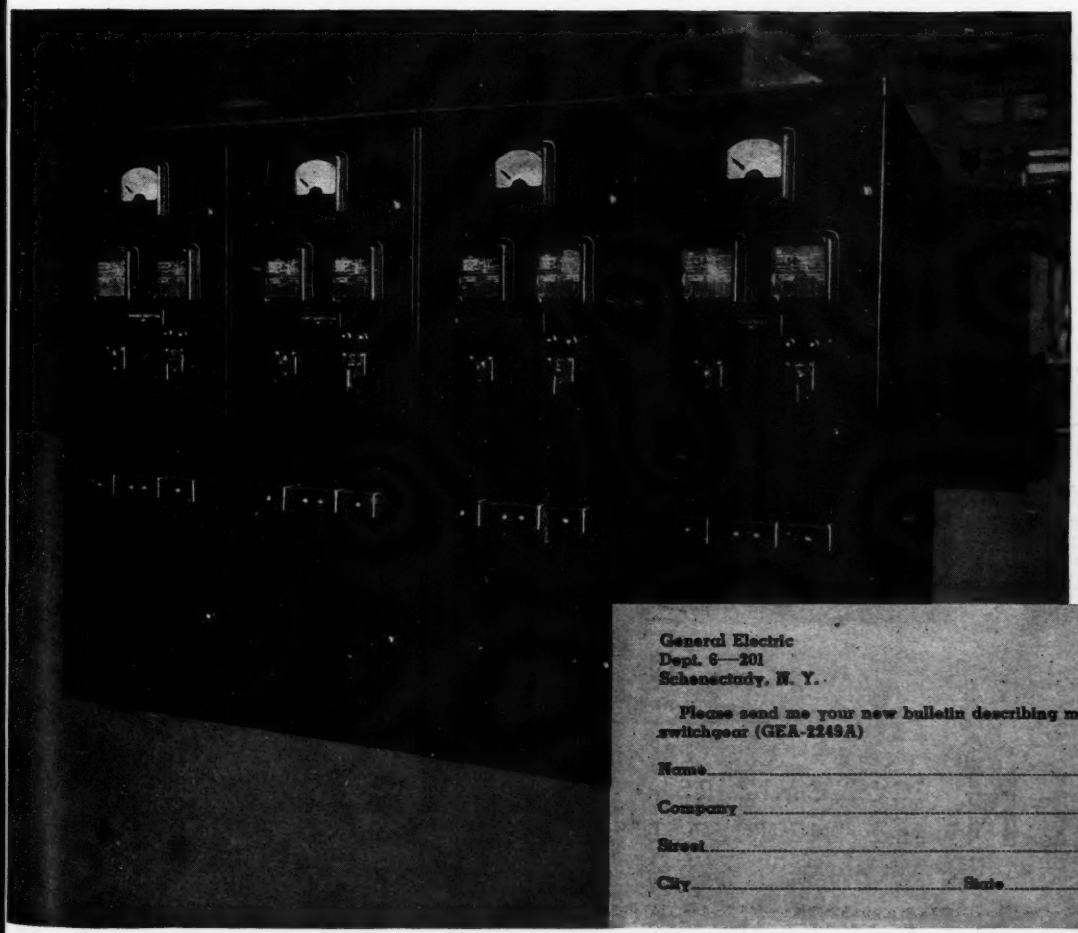
METAL-CLAD SWITCHGEAR, You Get Insurance That You Can Buy

BECAUSE you are giving your electric circuits and production machinery the swift, sure protection of a famous G-E oil-blast circuit breaker—similar in design to the heavy-duty breakers that power companies, steel mills, and other large industrials rely on for the protection of their highest-capacity electric circuits and equipment.

The midget metal-clad is safe—all live parts are completely enclosed—a system of interlocks guards against incorrect operation.

You will get other advantages, too. It cuts installation costs—you receive it completely assembled, ready to connect. It can readily be moved to a new location should that be desirable. It is moderate in cost.

Why not investigate the profitable possibilities of installing G-E midget metal-clad units in your plant? They are available for services up to 5000 volts; interrupting ratings up to 50,000 kva. For higher-capacity, heavy-duty jobs, rely on the G-E master metal-clad—Type MI-6. Mail the coupon today for complete information. General Electric Company, Schenectady, N. Y.



Four G-E midget metal-clad units with streamlined control panels—instruments and devices mounted semiflush

General Electric
Dept. 6—201
Schenectady, N. Y.

Please send me your new bulletin describing midget metal-clad switchgear (GEA-1249A)

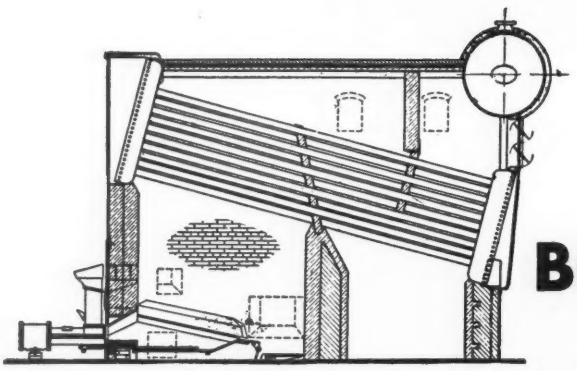
Name .....

Company .....

Street .....

City ..... State .....

350-10

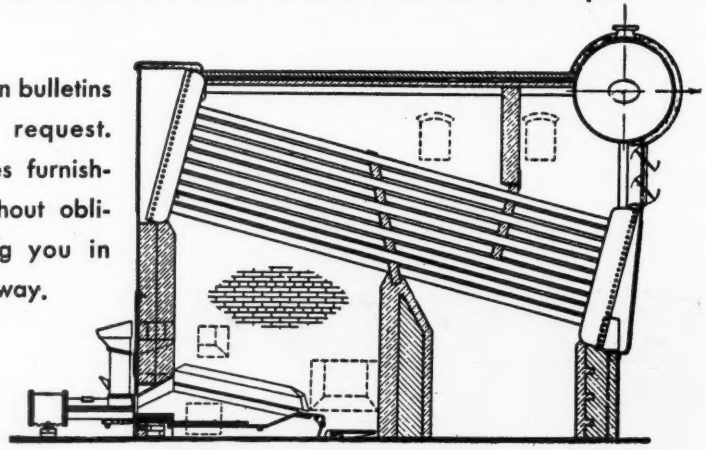


BOILER CAPACITY *increased*

AT LITTLE EXPENSE

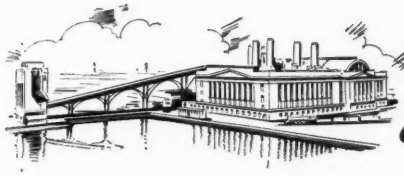
If you are operating without an economizer why not consider installation of one to increase your capacity at little expense? Our recently announced Extended Surface Economizer can probably be installed with very little changes in your building, flues, etc.—and give you that increased capacity you require. We can also supply you with Air Preheaters, Forced and Induced Draft Fans and Cindertraps.

Description bulletins sent on request. Estimates furnished without obligating you in any way.



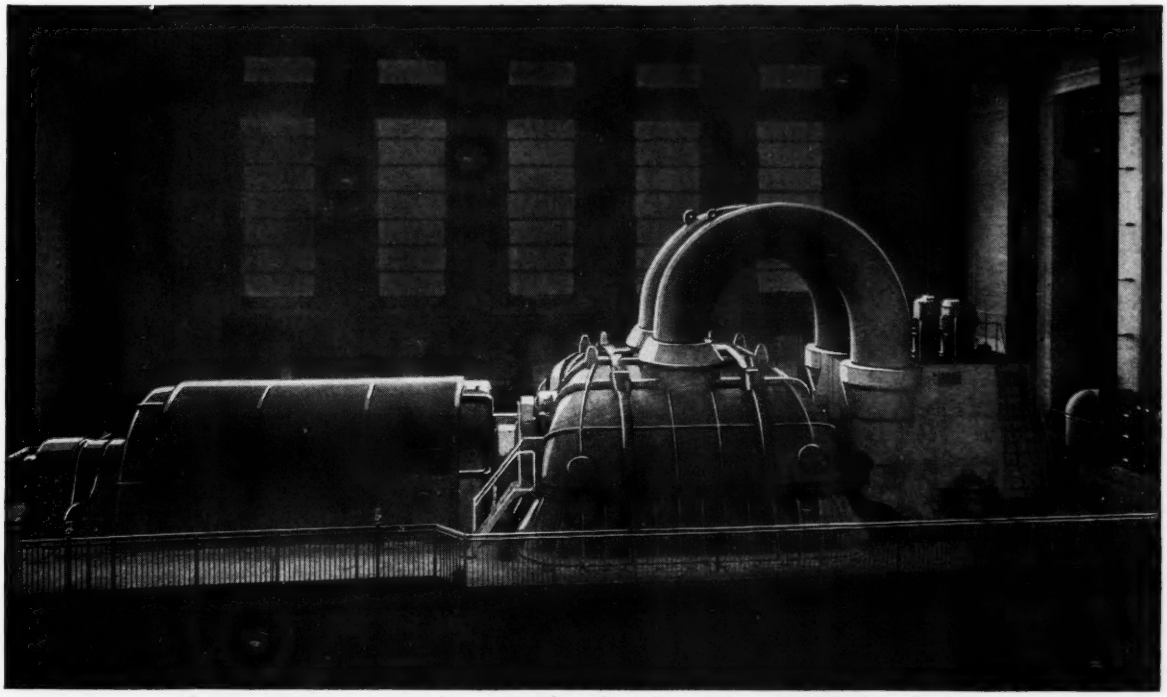
GREEN ECONOMIZERS • AIR PREHEATERS • FORCED and INDUCED DRAFT FANS • CINDERTRAPS

THE GREEN FUEL ECONOMIZER CO., INC., BEACON, N.Y.



Sturtevant Fans Serve

WORLD'S LARGEST SINGLE SHAFT TURBO-GENERATOR

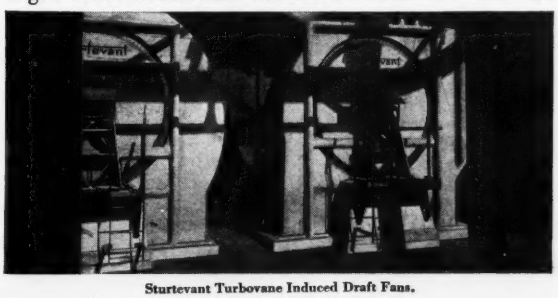


Westinghouse 183,333 kv.-a. generator, driven by 225,000 h.p. turbine in Richmond Station, Philadelphia Electric Company.

. . at Richmond Station . . Philadelphia Electric Co.

Four Sturtevant Self-cleaning Induced Draft Fans serve the 2 Babcock & Wilcox 600,000 lb. per hour pulverized-coal-fired boilers for this world's-record turbo-generator. They are rated 190,000 c.f.m. at 380°F. against 14.5 static pressure. Speed: 850 R.P.M.

Eight other Sturtevant Turbovane Fans are used for primary air and pulverized coal mill service.



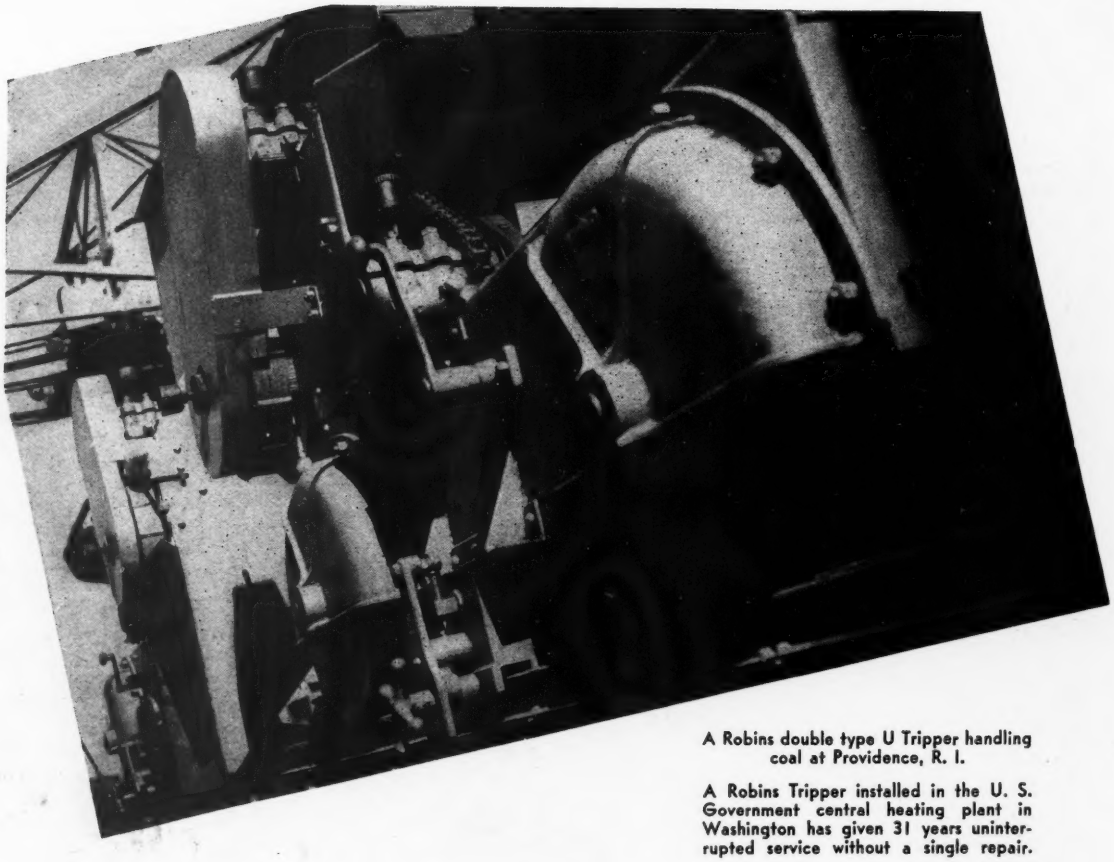
Sturtevant Turbovane Induced Draft Fans.

The addition to Richmond Station in which these Sturtevant Fans are installed was designed and constructed by United Engineers and Constructors, Inc., in cooperation with engineers of Philadelphia Electric Company.

B. F. STURTEVANT COMPANY, Hyde Park, Boston, Mass.
Branches in 40 Cities B. F. Sturtevant Co. of Canada, Ltd.—Galt, Toronto, Montreal

Sturtevant
REG. U. S. PAT. OFF.
Puts Air to Work

DRAFT FANS · TURBINES · GEARS · ECONOMIZERS · AIR HEATERS



A Robins double type U Tripper handling coal at Providence, R. I.

A Robins Tripper installed in the U. S. Government central heating plant in Washington has given 31 years uninterrupted service without a single repair.

TRIPPERS *of all kinds*

While the tripper may represent only a small fraction of the dollar value of your plant, its proper functioning determines the efficiency of the whole coal handling system. This is why Robins has gone to such extreme engineering effort to develop trippers that give continuous automatic operation . . . ***without shutdown.*** Robins Trippers are made in a wide variety of types and sizes both automatic and hand propelled, both single and double. You want to know more about Robins coal and ash handling specialties. Write today for information.

MATERIAL HANDLING
ROBINS
EQUIPMENT

Robins manufactures and sells all units for construction and maintenance of material handling systems and also offers a designing and erecting service.

ROBINS CONVEYING BELT CO., 15 Park Row, New York

☐ Please have your representative call. ☐ Please send me bulletin about.....

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Name .....

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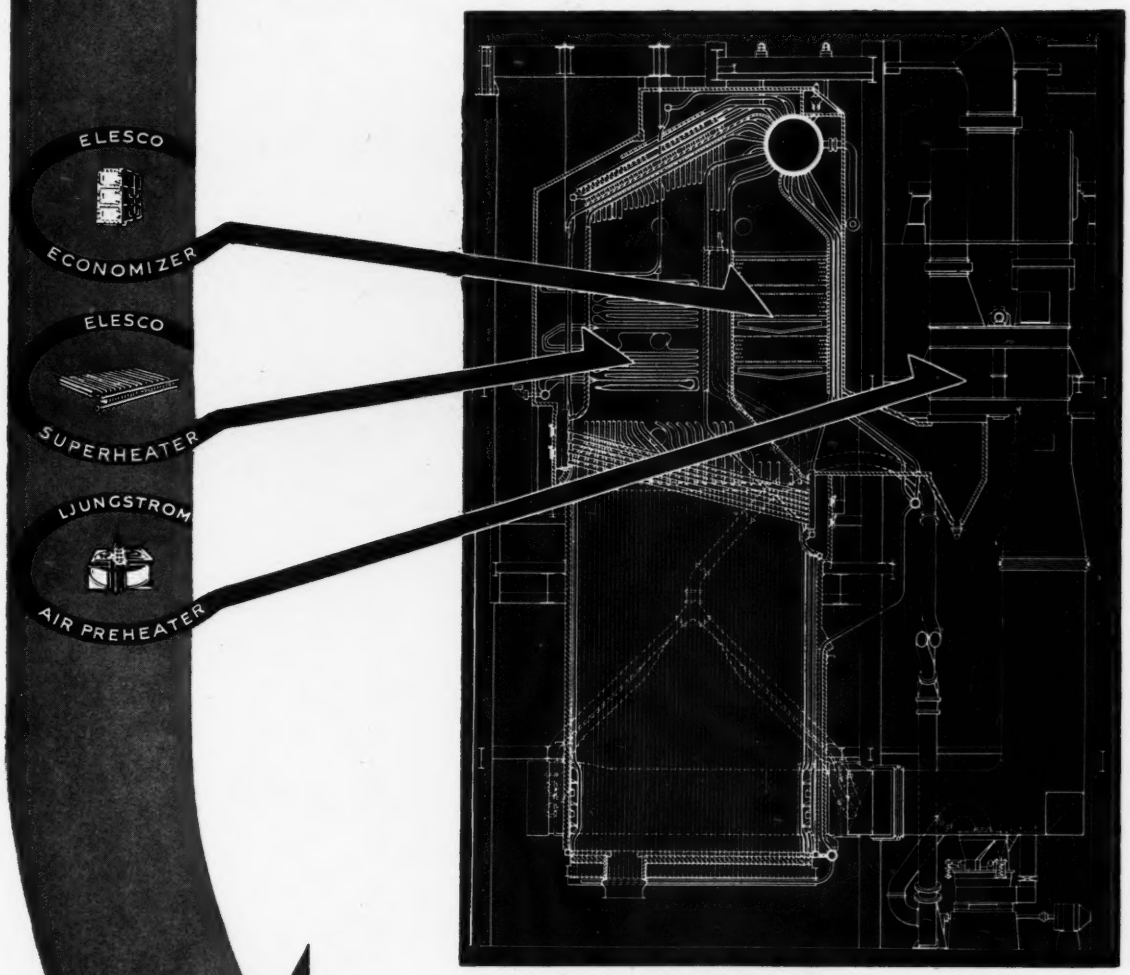
Town .....*State* .....*P*

ROBINS MAKES:

Belt Conveyors
Pivoted Bucket Conveyors
Bucket Elevators
Crushers Feeders
Weigh Larries
Gates Grab Buckets
Trippers Skip Hoists

Expansion . . . . . .

IN THE PLANT OF A LEADING *EASTERN* UTILITY STATION



ESSENTIAL COORDINATION PROVIDED BY ELESCOORDINATED SUPERHEATERS, ECONOMIZERS AND AIR PREHEATERS . . . . . .

Steam Temperature	900° F
Water Temperature	506° F
Air Temperature	509° F
Capacity per Hour	500,000 lb.

ELESCO **ORDINATED**

Copyright 1936 • The Superheater Company • 60 East 42nd St., New York

The adaptability of the Taylor Stoker makes

There are, in the United States, six great coal fields—furnishing most of the steam coals the power plants of this country consume. The B.T.U. value and ash content of these coals vary widely, roughly from 8,500 to 14,500 B.T.U. per pound as fired and from 40 to 5% respectively. Comparable differences are likewise found in the sulphur content and ash fusing temperatures.

Taylor stokered central stations and privately operated plants are generously peppered throughout each of the six areas and between them. These Taylor Stokers are not only able to burn efficiently coal local to them but their adaptability makes it possible to switch on occasion from the coal of one area to that of another, to take advantage of any favorable price differential, freight included. Why?—because Taylor Stokers are so readily adjusted for any particular coal and because no special preparation is required before the coal is burned. One plant in Ohio, for example, has successfully burned 21 different coals—and burned them at an efficiency justifying their use.

This adaptability of the Taylor Stoker is not happenstance. It is one result of 30 years' experience accumulated by the world's largest engineering force devoted exclusively to the development of multiple retort underfeed stokers.

DIVISION: American Engineering Company, 2408 Aramingo Ave. Philadelphia. IN CANADA: Affiliated Engineering Corporations, Ltd., Montreal, P. Q. OTHER PRODUCTS: A-E-CO Lo-Hed Monorail Electric Hoists, A-E-CO Hele-Shaw Pumps, Motors and Transmissions, A-E-CO Marine and Yacht Auxiliaries

THE

A-E-CO

TAYLOR STOKER UNIT

TAYLOR STOKERS • A-E-CO WATER WALLS • A-E-CO ASH HOPPERS

Cooled in Summer Warmed in Winter

with TRADE FRICK MARK

Refrigeration

This well known theatre at Miami Beach, Florida, is one of several Frick installations which operated through the past winter on reversed refrigeration for supplying heat.

As these systems collect up to ten dollars' worth of heat for every dollar's worth of power, they offer further proof of the superior economy of Air Conditioning with Frick Refrigeration.

Estimates on a Frick system to suit your requirements will be cheerfully submitted.

WAYNESBORO, PENNA. U.S.A.

FRICK CO.

DEPENDABLE REFRIGERATION SINCE 1882

BROS BOILERS installed at OLSON RUG CO.

FOLLOWING are important characteristics of the two 450 b.hp. Bros units serving Olson Rug Co., Chicago:

1. Low exit gas temperatures.
2. Bros-Weatherbee ring flow circulation insures high heat absorption.
3. Highest steam temperature of any isolated plant in or around Chicago.
4. Bros convex-type superheater provides 200 deg. superheat.
5. Operate up to 250 per cent rating. Write today for descriptive folder.

WM. BROS BOILER & MFG. CO.
Minneapolis, Minnesota
Chicago Office—53 W. Jackson Blvd.

WICKES BOILERS

Horizontal Cross Drum Boilers
Vertical Water Tube Boilers
Inclined Curved Tube Boilers
Horizontal Tubular Boilers

THE WICKES BOILER CO
SALES OFFICES:
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CHICAGO, 38 SO. CLARK ST. DETROIT, 2357 UNION TRUST BLDG.

YOUR BOILERS NEED • • SOFT WATER • •

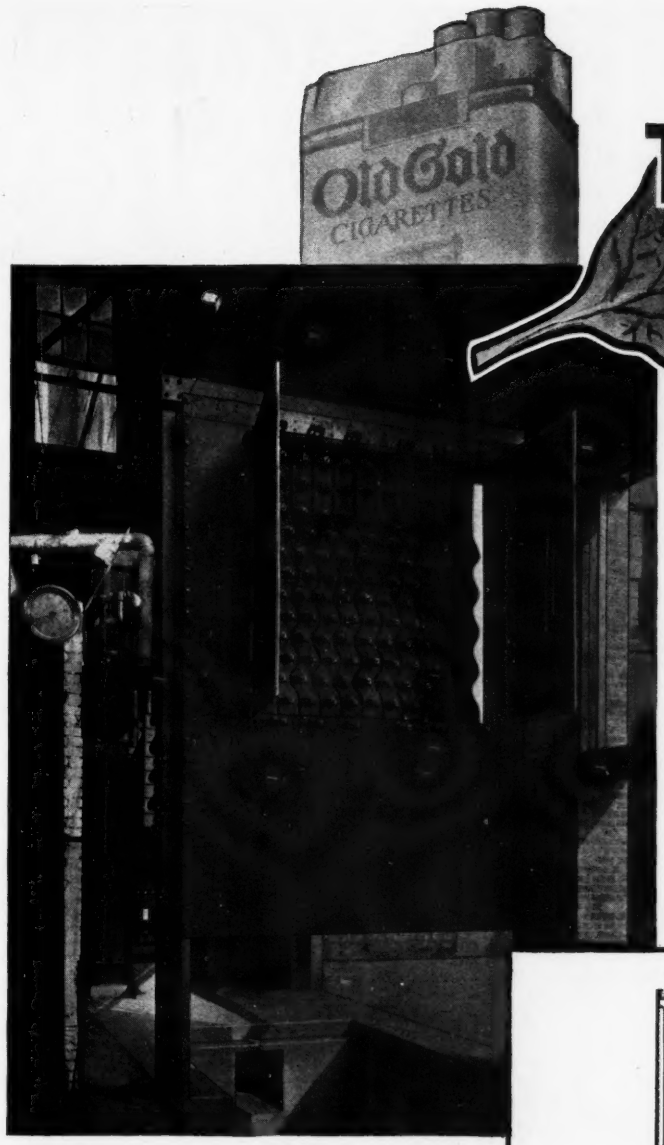
WE MANUFACTURE ALL SIZES AND TYPES OF WATER SOFTENERS & FILTERS

Cold Process: Intermittent, Continuous and Zeolite. Hot Process, Semi-Hot Process and specially designed Water Softeners.

Gravity, Pressure and Oil Removal Filters.

WRITE FOR INFORMATION AND BULLETINS.

WM. B. SCAIFE & SONS CO.
OAKMONT, PA.
NEW YORK PITTSBURGH CHICAGO

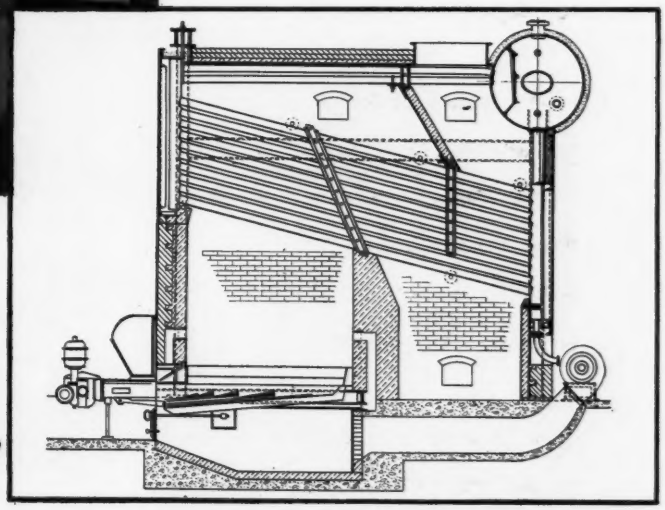


TOBACCO PLANTS

. . . which rehandle the leaf in processing it for the finished product, are among many industries turning to boiler plant modernization for dependable, rock-bottom-cost steam production.

The P. Lorillard Company, makers of Old Gold cigarettes, has installed in their Louisville plant the 253 horse power boiler illustrated, which is of the forged steel sectional header type.

Vogt boilers of many types offer a wide selection to meet the requirements of those who use steam for power or process.



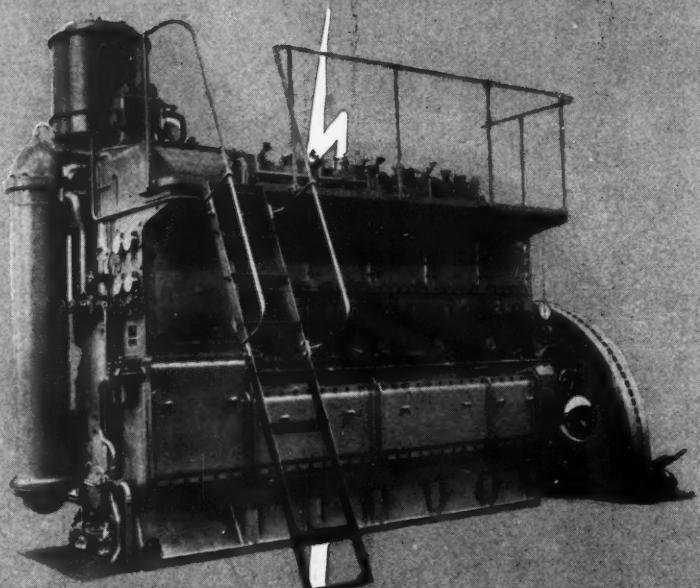
Manufacturers of: Water Tube Boilers, Drop Forged Steel Valves and Fittings, Oil Refinery Equipment, Ice Making and Refrigerating Machinery, Heat Exchangers.

Vogt *forged steel* SECTIONAL HEADER BOILERS

Henry Vogt Machine Company
Incorporated
LOUISVILLE, KENTUCKY

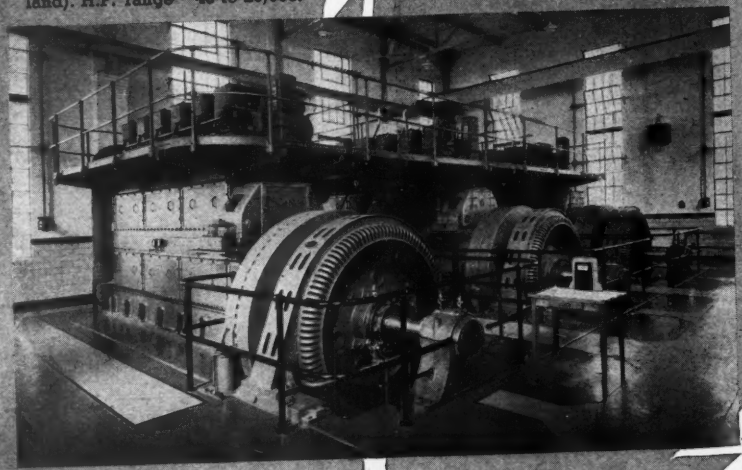
NEW YORK · CHICAGO · PHILADELPHIA · CLEVELAND
CINCINNATI · DALLAS · KANSAS CITY

modern Diesel



Above—Alco-Sulzer 2-Cycle Diesel Engines (Sulzer Brothers, Winterthur, Switzerland). H.P. range—40 to 20,000.

Below—McIntosh & Seymour 4-Cycle Diesel Engines. H.P. range—80 to 8,000.



ALCO

POWER

THE name under which a product is made and marketed plays an important part for good or ill in the growth of the institution behind it.

If it represents the energizing force of endeavor, if it symbolizes progress, it becomes a criterion of excellence by which all others in its field are judged.

Therefore, a good name must always be safeguarded. Its owner is inseparately associated with his product for the name indicates the purpose of one and the quality of the other, which forbids a lower standard of either when confidence once is gained. Such a name is ALCO.

Alco products express the character of the builder in the delivery of quality and performance to the buyer. They reflect the aim of a personnel whose unfailing devotion to the cause of service ranks first.

McIntosh & Seymour four-cycle Diesel designs, and Alco-Sulzer two-cycle Diesel designs are products of ALCO. They and their builder are inseparately associated. Through their sustained operating economy, convenience, dependability and long life, they have earned the distinction of delivering the utmost in trustworthiness.

AMERICAN LOCOMOTIVE COMPANY

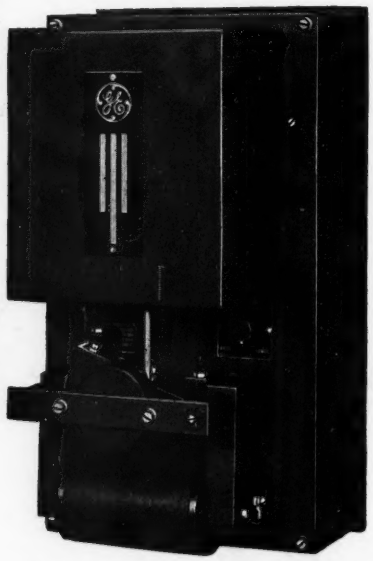
DIESEL ENGINE DIVISION

OFFICE AND WORKS, AUBURN, N. Y.

NEW YORK, N. Y., 30 Church St. BOSTON, MASS., 20 Newbury St. CHICAGO, ILL., McCormick Bldg. WASHINGTON, D. C., Barr Bldg.
HOUSTON, TEXAS, Esperson Bldg. KANSAS CITY, MO., Commerce Trust Bldg. SAN FRANCISCO, CAL., Bourn Bldg.

"....a commendable contribution to voltage-regulating apparatus,"

says Frank Reilly, Chief Engineer, G and N Engineering Company



No dashpot

No vibrating contacts

Little or no maintenance

Direct action

Inherently smooth

Five different sizes

Type GDA generator-voltage regulator

THE C. E. Bradley Corporation of Brattleboro, Vermont—a large manufacturer of wood products—installed a 175-kw, engine-driven generator to supply its own electric power. The G and N Engineering Company of Boston, Mass., designed and constructed the switching and control system.

THE VOLTAGE VARIED

G and N engineers were faced with a problem of voltage regulation. Both lighting and power were supplied from the same bus. Equipment included two 25-hp bandsaws, started and stopped frequently, besides the usual small-capacity, motor-driven woodworking machinery, with its variable-load characteristics.

THE SOLUTION

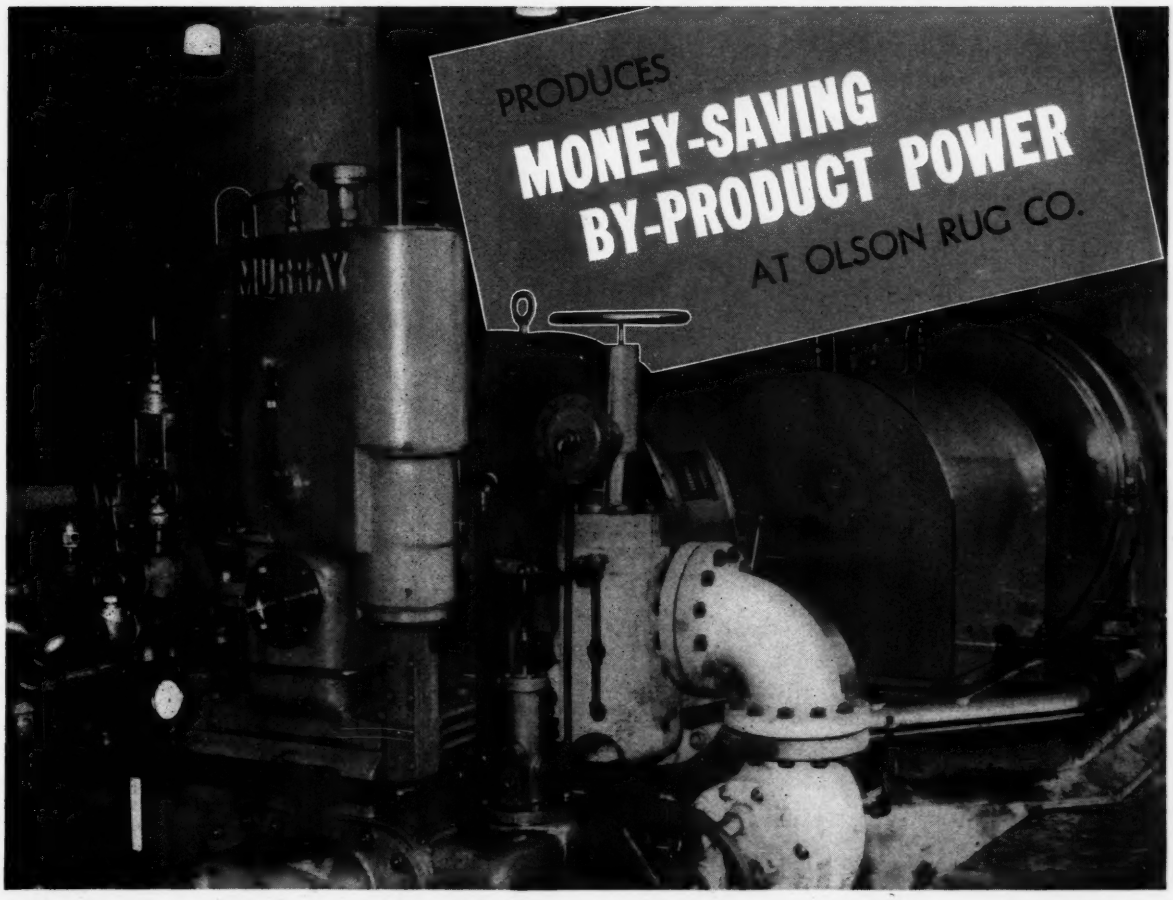
After a careful investigation, they decided to install a G-E (Type GDA) voltage regulator. That was a year ago. Now they say, "We feel that the elapsed time has been sufficient for us to go on record that this new regulator has proved itself a piece of excellent equipment for maintaining CLOSE voltage regulation. Our observations of this regulator on a comparative basis are that the adjustment is simpler, the action is faster, and the operating characteristics are such that the resistance variation is gradual, causing a swaying voltage regulation rather than distinct jumps."

The new, simplified, G-E (Type GDA) regulators, for controlling the voltages of both a-c and d-c generators and synchronous motors and condensers, are now available in five different sizes, suitable for small and medium-sized machines. Type GDA regulators are easy to install, have only six leads to connect, and can be mounted on a switchboard panel or on a supporting bracket.

You may be able to make similar improvements in your plant with these regulators. Why not get in touch with your nearest G-E sales office, or write for GEA-2022A, which gives complete information. General Electric, Dept. 6F-201, Schenectady, N. Y.

630-8

GENERAL ELECTRIC



Shown in the photograph is one of two Murray Non-Condensing Turbines installed in the ultra-modern plant of the Olson Rug Company, Chicago.

These Murray Turbines deliver inexpensive by-product power by effectively utilizing steam required for heating and process work.

The advantages of this installation of Murray Turbines are to be expanded by the addition of a third Murray Turbo-Generator Unit now under construction. The new unit of 1000 K.W. capacity will maintain the heat balance under increasing electrical load and process steam demand.

Let us tell you how these improved power units can show savings in your plant.

MURRAY IRON WORKS COMPANY, Burlington, Iowa, U.S.A.

Other Murray Products

Water Tube Boilers

Una-Flow Engines

Corliss Engines
both releasing and
non-releasing type

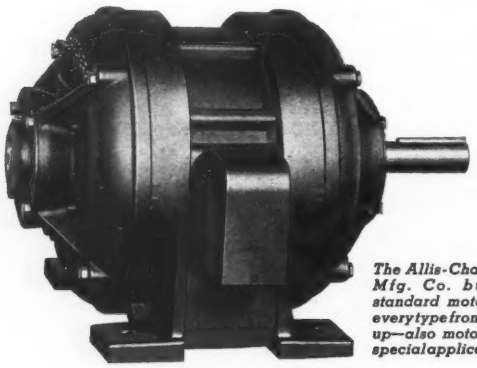
MURRAY

THE *Proprietor*

EATS IN ANOTHER RESTAURANT

IT'S an old quip . . . about the restaurant proprietor who steps out for his lunch. But its implication is deadly—he doesn't eat his own food.

We manufacture motors. We also manufacture the most diversified line of machinery of any company on the American continent, and that machinery is driven by the motors that we build . . . by Allis-Chalmers motors.



The Allis-Chalmers Mfg. Co. builds standard motors of every type from 1 hp. up—also motors for special applications

All the engineering skill and ability that have gone into the development of that vast and distinguished line of mechanical and electrical machinery have contributed to the development of Allis-Chalmers Motors; for our policy is one of undivided responsibility and the highly specialized knowledge and experience of every department is exchanged with that of every other department where it may have any bearing. It is from this wide and varied background that we designed and developed Allis-Chalmers Motors specifically for industrial application.

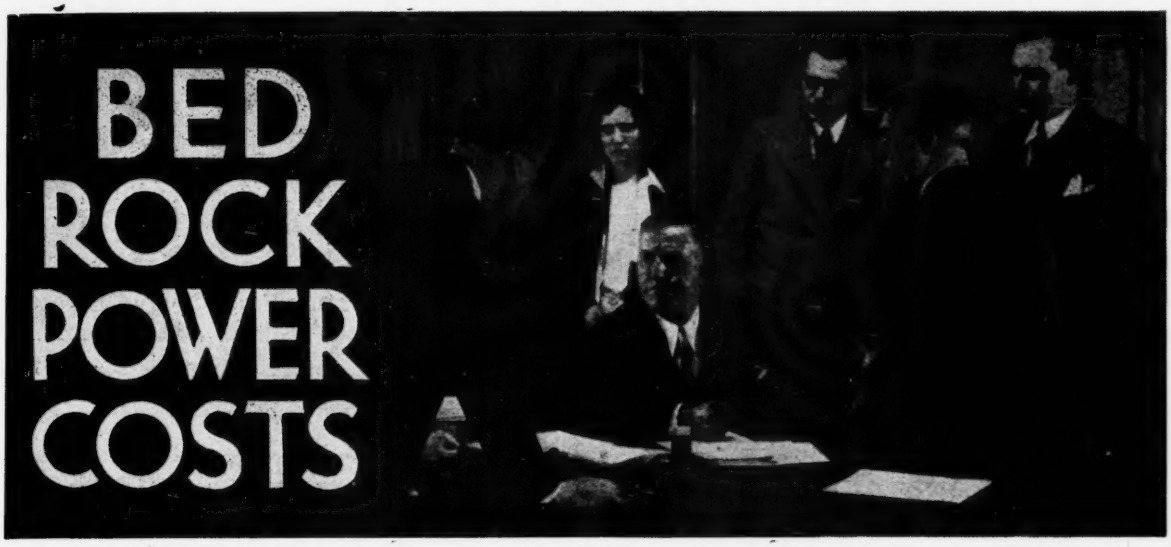
Allis-Chalmers Motors excel because they are the sturdiest motors on the market today—bar none. And they are the most profitable motor buy on the market today—bar none, because their great mechanical and electrical strength reduces maintenance costs to the minimum and extends their life beyond that of all less sturdily constructed motors.

MOTOR DIVISION

ALLIS•CHALMERS

FOR EVERY PURPOSE

MILWAUKEE WISCONSIN



Here's His Answer!!!

Is your plant one of the many that—for numerous reasons—has just got to get its costs down?

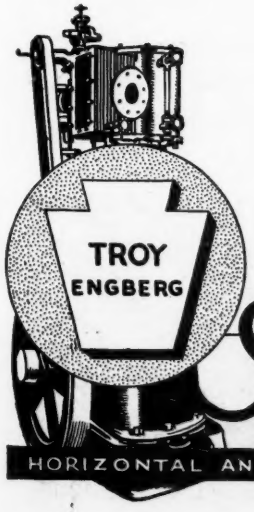
Investigate Troy-Engberg By-Product Power. Investigate the use of the modern Troy-Engberg Steam Engines for driving your stokers, fans, compressors, pumps, generators, etc. Investigate the modern Troy-Engberg Engine Generating Set for producing AC or DC current for night, holiday, emergency or week-end loads. Both are By-Product Power units.

Many hundreds of these units have been bought during the past year or two by concerns that have really studied the advantages of By-Product Power. They were bought for the definite purpose of reducing power costs. With them, steam does double duty. The exhaust, oil-free if desired, carries the required heat units formerly supplied by live steam and, for these installations, provides the best plant heat balance.

Our new Catalogue "Modern Steam Engines" gives more details regarding this basic principle of By-Product Power. Send for your copy.

A few of the Many Recent Purchasers of Troy-Engberg Engines or Sets:

Fisher Body Company
Oakdale Butter Assoc.
Scranton High School (Pa.)
Welfare Island (NY) Hospital
El Paso Natural Gas Co.
Union Carbide & Carbon Co.
Sun Oil Company



Troy Engine & Machine Co.

813 Railroad Avenue, Troy, Pennsylvania

Save with By-Product Power

HORIZONTAL AND VERTICAL STEAM ENGINES · A.C. & D.C. GENERATING SETS

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